INTERAVIA

World Review of Aviation and Astronautics
with Electronics Supplement

IN THIS ISSUE

PARIS— Shop Window of the World's Aircraft Industries

Target and Reconnaissance Drones

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Volume XVI

INTERAVIA

May 1961

WORLD REVIEW OF AVIATION AND ASTRONAUTICS

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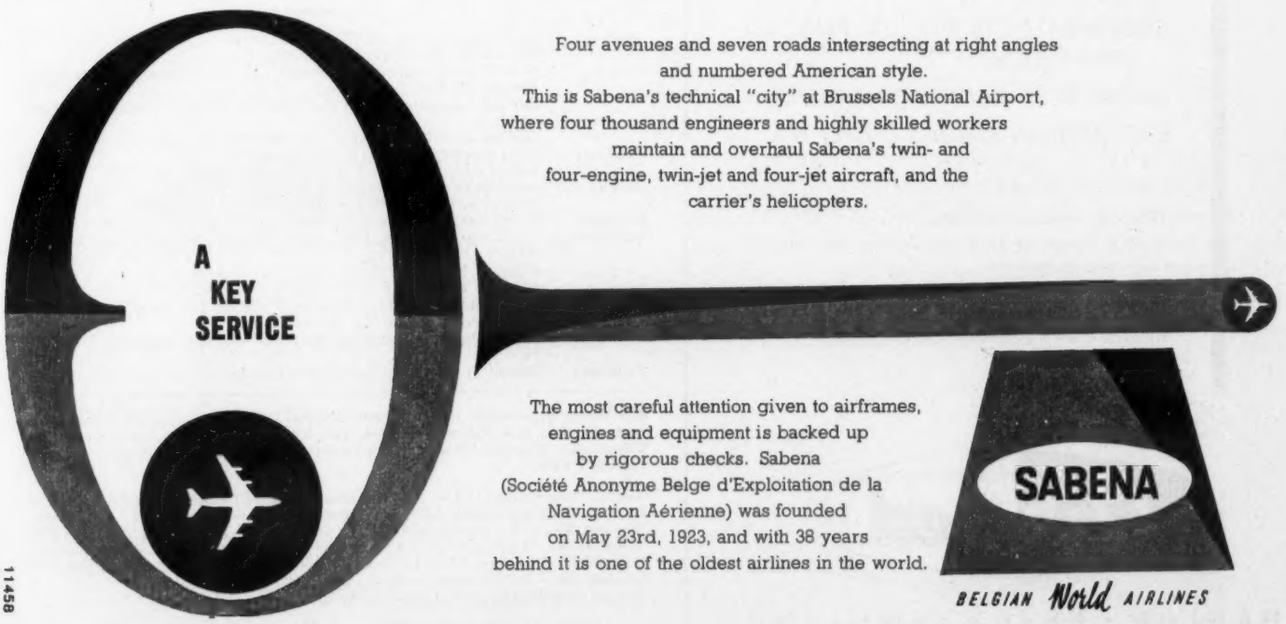
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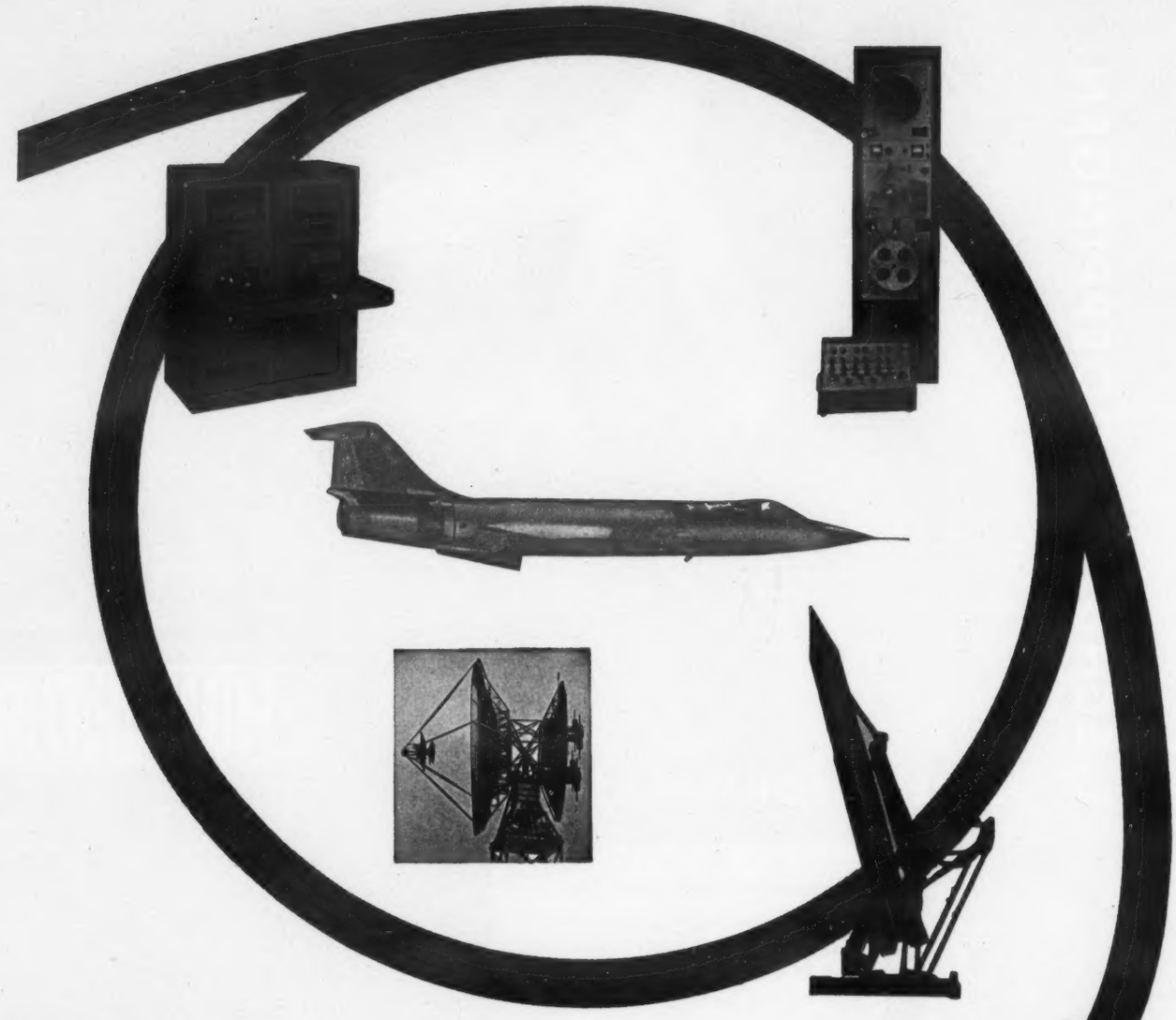

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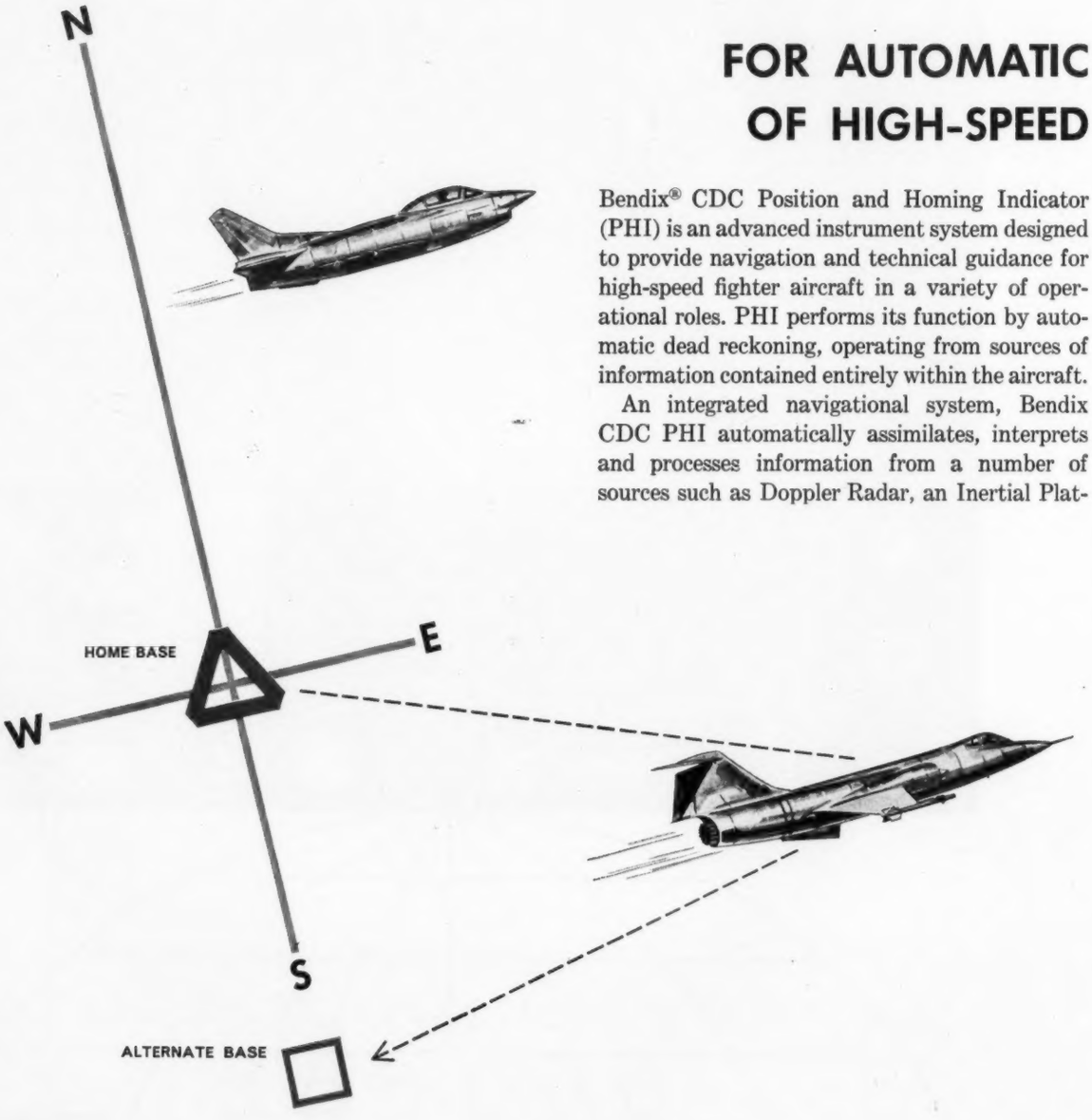

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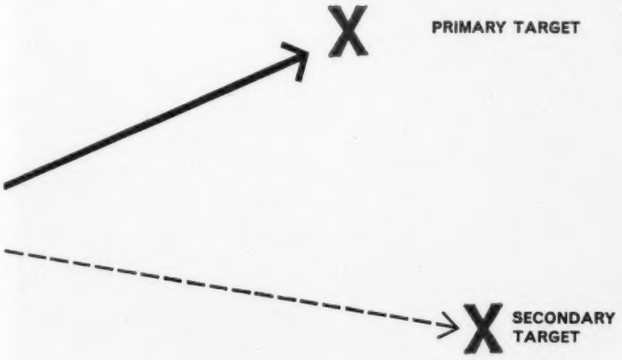

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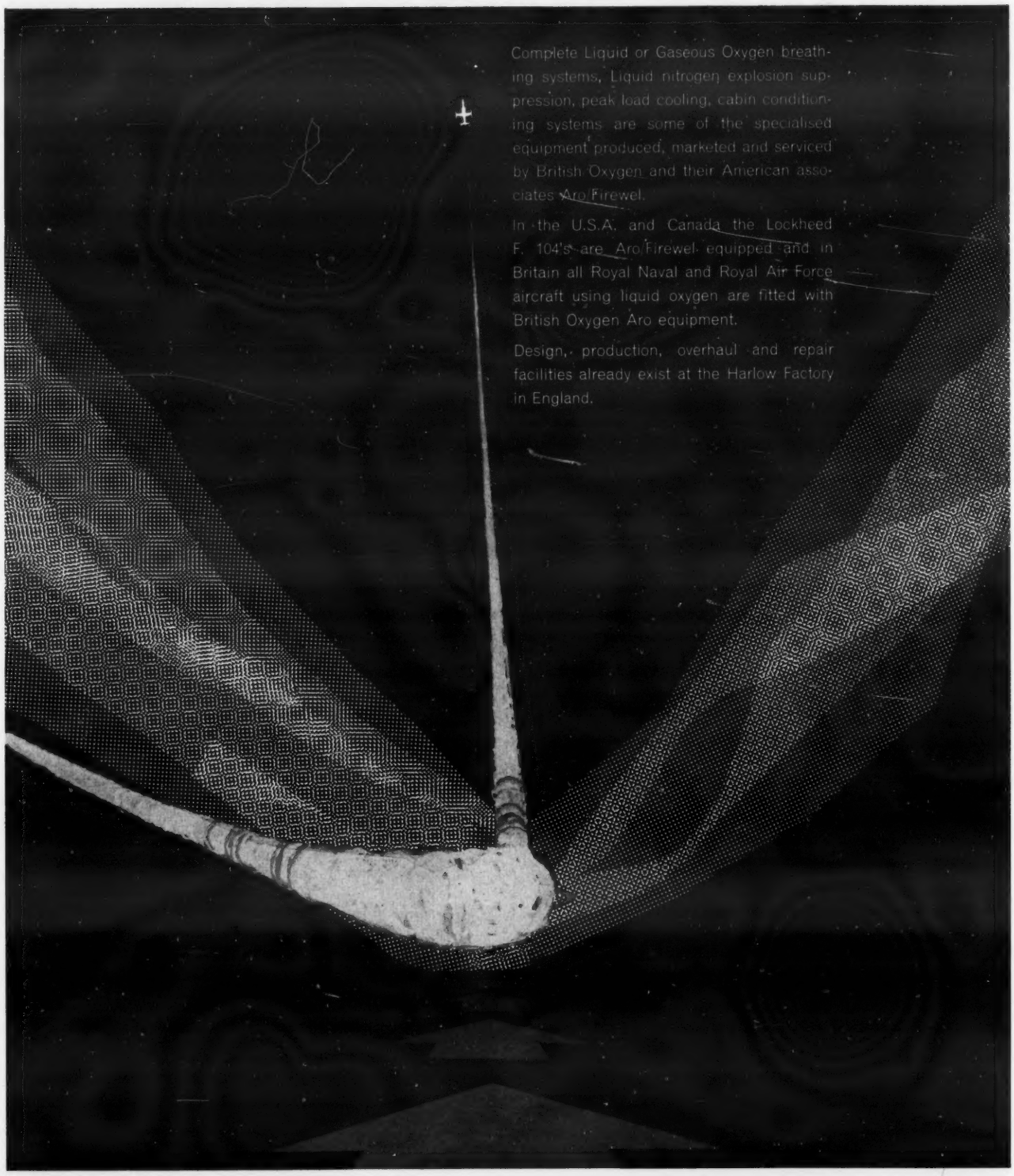

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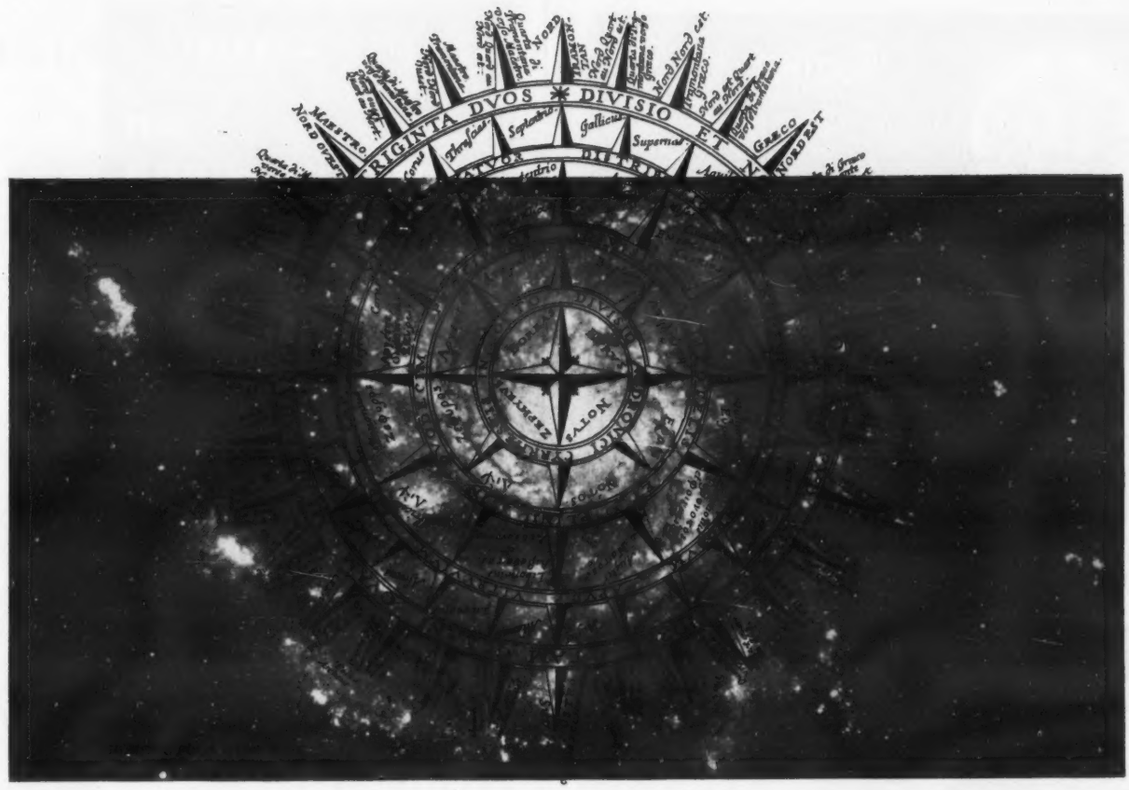

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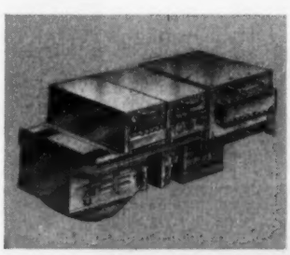

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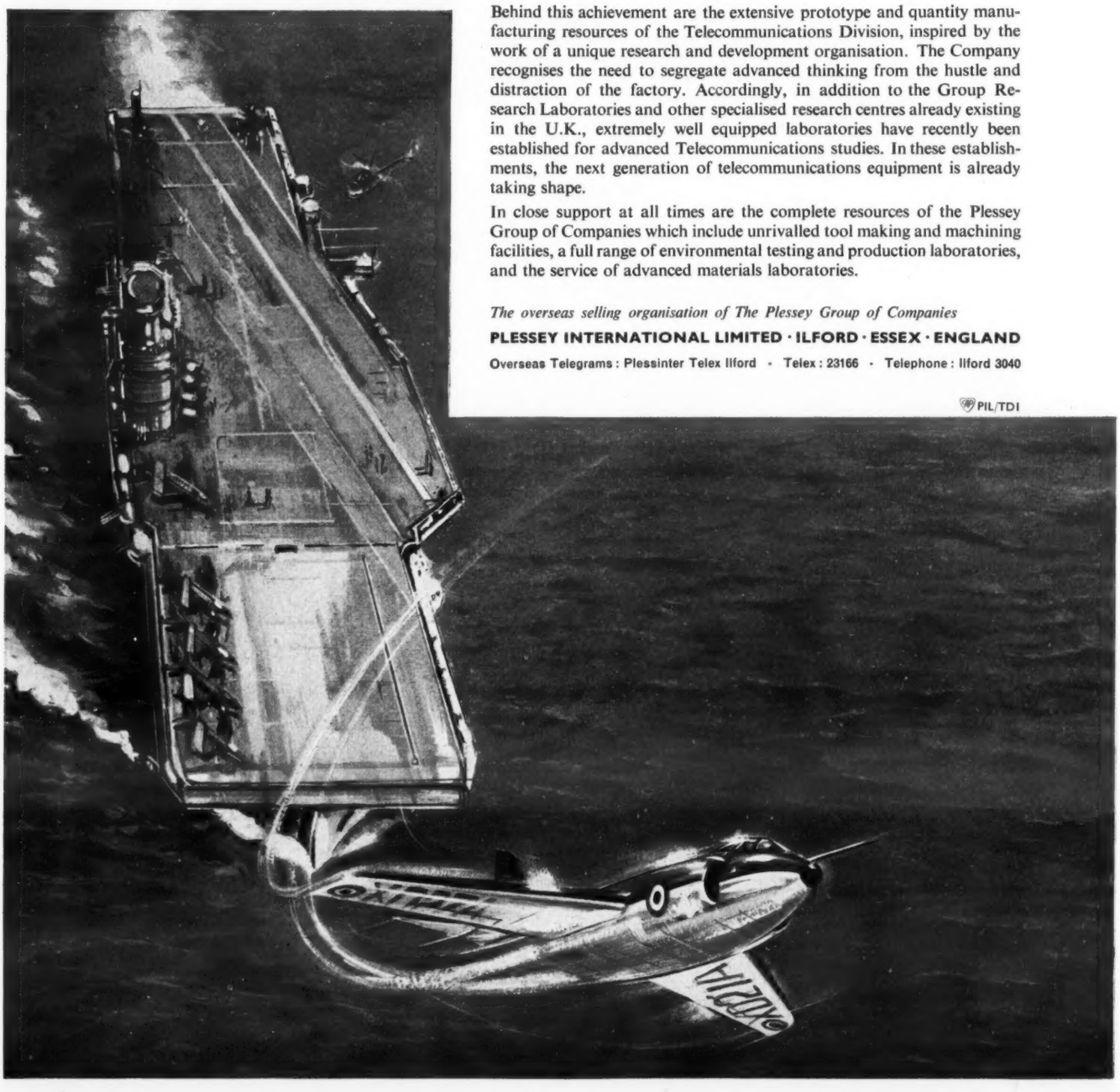

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INTERAVIA AIR LETTER reports...*

Air Transportation

KLM Royal Dutch Airlines will now probably get long-sought landing rights at Los Angeles International. The U.S. Air Transport Association is protesting, but the State Department appears willing to agree the KLM request dating back to 1956. KLM currently has a New York-Curaçao route plus entry into Houston.

●

SAS Scandinavian Airlines System will introduce Douglas DC-8 (series 30) jets into service on the southern route to Tokyo on September 28th. Provisional schedules cover a Thursday and Saturday flight through Europe, Middle East, India, Burma and the Philippines. Westbound flight will depart Tokyo Monday and Saturday. SAS will also operate once-weekly DC-7C service on the route.

●

BEA and Aeroflot London-Moscow jet services are increased from two roundtrips a week each to six direct flights a week effective May 1st.

●

Air France summer schedules cover two Boeing 707 services a week to Caracas. Flights depart Paris-Orly Monday and Thursday on the route Lisbon-Santa Maria-Point à Pitre-Caracas with a flight time of 11 hours. Eastbound flight time on Monday and Saturday is 10 hours, by-passing Santa Maria.

●

Swissair adds Khartoum to its route network with a once-weekly DC-6B service effective May 2nd. Departures 22:40 hours Zürich on the route Geneva-Athens-Cairo. Northbound services depart Khartoum Wednesday. Swissair has also confirmed charter of two 880-22M jet transports from Convair to meet delays in 990 *Coronado* deliveries. The two 880s will go into service on the carrier's Far East route this autumn.

●

British United Airways may purchase cross-channel car ferry operator Silver City Airways following discussions in London last month. No firm decision has been taken, but this move would mean an amalgamation of Channel Air Bridge and Silver City ferry operations.

●

Air Afrique, the new operating company to be formed by the African States within or associated with the French Community, will have an initial capital of 500 million CFA francs ($500,000). The eleven African States will control 66 percent, with the balance held by UAT and Air France. Headquarters will be at Abidjan in the Ivory Coast, and initial fleet will probably comprise 15 Douglas DC-4s. Operations are expected to commence three months after ratification of the treaty and protocols agreed in Yaoundé in April.

The Lebanon has refused a Pan American World Airways' request to operate a freight service Beirut-Rome-Paris.

●

National Airlines has ordered seven DC-8 series 50 jet transports, bringing Douglas order book up to 165 aircraft. Braniff International has ordered a fourth Boeing 720-027 for delivery in May 1962.

●

Pakistan International Airlines has received government approval to purchase three Boeing 720B turbofan transports. First delivery December 1961 and the other two late in 1962.

●

H. Don Reynolds, Assistant VP American Airlines, joined IATA as Traffic Director on April 17th, taking over the post vacated by J. W. S. Brancker last year.

Industry

Bendix Systems Division has received a $17,260,000 "definitive contract" from the U.S. Army for development of the communications systems for the Project *Advent* communications satellite. Work has already started under an earlier $2 million letter contract. Bendix Radio Division will design, install and operate two ground terminal sites near Fort Dix, N.J., and Camp Roberts, Calif. The U.S. Navy is modifying a *Victory* ship to operate as a third surface communications base.

●

North American Aviation is developing a low-speed, zero-altitude rocket catapult for ejecting jet pilots, under a USAF contract. A twelve-week sled testing programme will start at Edwards AFB this month, and success could lead to quantity production for equipping F-100 *Super Sabres* currently in service with the USAF.

●

Dr. Theodore von Kármán, leading personality in the field of aerospace sciences, will be honoured by a Symposium and Banquet sponsored by the Air Force Office of Scientific Research on the occasion of his 80th birthday on May 11th. Under-Secretary of the Air Force Dr. Joseph V. Charyk will be the principal speaker at the Sheraton Park Hotel, Washington, function.

●

Marconi's Wireless Telegraph Company is supplying 18 SD 1010 fixed-coil radar display units for use in conjunction with the S-264 50-cm surveillance radar now being installed at Brussels National by SA Internationale de Télégraphie Sans Fil (SAIT) of Brussels.

●

Armstrong Whitworth Aircraft (HSG) may get a £2 million order from BEA for three AW.650 *Argosy* freighters. The BEA order would bring the *Argosy* order book up to 66 aircraft.

●

Sud-Aviation has five *Caravelle 7s* on the production line, and first roll-out is scheduled for January 1962. First deliveries available October 1962. The General Electric *Caravelle,* which will be shown in Paris, had logged 85 flight hours with the new powerplant by mid-April.

Morane-Saulnier will manufacture the three-seat MS.880 *Rallye* and MS.885 *Super Rallye* at the rate of 30 aircraft a month in July, increasing to 60 a month from March 1962. At mid-April the company had orders for 311 *Rallye* models from 21 countries.

●

Saab Aircraft Company reports 1960 gross sales totalling Skr. 520 million, the first time that the company has ever published this information. No breakdown between civil and military sales was given, but major progress was reported in electronic computing and bomb-aiming equipment.

●

Rietdorf Company of Coblenz has been retained by the West German Defence Ministry as advisor on ground service equipment for the Lockheed F-104G.

●

Piaggio will build two prototypes of a new 6-seat twin-jet utility aircraft based on a Douglas design, with first flight scheduled for 1962. A civil version will be designated PD-808, and a military version would cover such missions as training, transport and limited war combat support. Douglas has completed preliminary resign study, and detailed design and prototype construction will be handled by Piaggio at Genoa. The design covers twin-jet engines with thrust up to 3,000 lb to give a cruising speed of 500 mph at 40,000 ft with pressurized cabin. The Italian Air Force is reportedly showing considerable interest in the project.

Military Affairs

The Canadian Government has given Canadair a $21,295,000 contract for five swing-tail CL-44D transport aircraft and spare parts for RCAF Transport Command. RCAF already has twelve side-loading CL-44s. The Canada-U.S. aircraft swap deal now appears to be firm and reportedly covers McDonnell F-101B interceptors for the RCAF and a U.S. purchase of some 100 Canadair CF-104s for NATO countries. Re-equipment of five RCAF squadrons with F-101Bs could open a potential market for Canadair's CL-41 two-seat basic jet trainer.

●

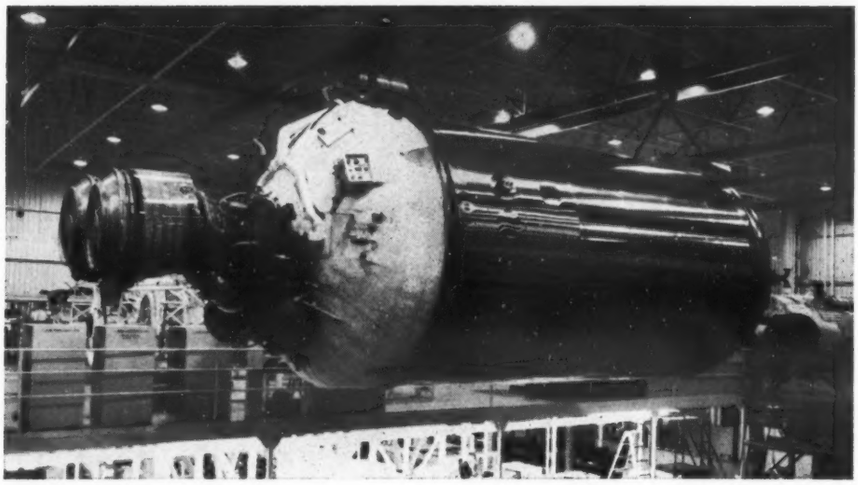
U.S. Defense Department has given General Dynamic's Electric Boat Division a $76,2 million contract to build two *Polaris* FBM submarines of the improved *Lafayette* class. Newport News Shipbuilding & Dry Dock Co. has a similar $75.3 million contract for a further two, and a fifth has been assigned to the Mare Island Naval Shipyard. Contracts do not cover propulsion machinery, electronic equipment or weapons systems.

●

The Australian Government has ordered eight Bell 204B helicopters, spare parts and ground handling equipment to equip the RAAF's No. 9 Search and Rescue Squadron. Delivery will be completed in 1962 and the contract is valued at £A1,860,000. Current Australian Navy, Army and Air Force plans for standardization on helicopter equipment may cover procurement of some 300-400 aircraft over the next few years.

The INTERAVIA Annual General Meeting has regretfully accepted the resignation of Marcel Devaud as Chairman of the Board and Managing Director. He is succeeded as Chairman of the Board of Directors by Professor Eduard Amstutz, Chairman of the Executive Board of the Swiss Federal Material Test and Research Institute (EMPA) of Zurich. Mr. Devaud has been appointed Honorary Chairman of the Board in recognition of his many years' service to the company.

* Interavia Air Letter is a daily international news digest published in English, French ("Courrier Aérien") and German ("Luft-Post"). All rights reserved.



The first complete *Centaur* second stage leaves the San Diego facility of the Convair (Astronautics) Division of General Dynamics Corp. for static tests at Sycamore Canyon. Powered by two Pratt & Whitney XLR-115s, each delivering 15,000 lb thrust, the *Centaur* is the first American booster to use lox/liquid hydrogen as a propellant. Together with the first stage, a modified *Atlas D*, it will be used to put space probes into solar orbits in 1962 and to land the *Surveyor* (cf. *Interavia* No. 4/1961, page 494) on the moon in 1963. The maximum diameter of the *Atlas-Centaur* booster is 10 ft, its overall length 107 ft 8 in.

British Navy's *Seaslug* surface-to-air-missile trials have given better results than anticipated, according to the Admiralty. The guided missile's trial ship, *Girdle Ness*, is back in Devonport for a short refit but will return to Malta to complete trials in July. The Armstrong Whitworth *Seaslug* will be main armament of the new *Hampshire* class of guided missile destroyers.

●

West Germany has dropped plans to form two guided missile wings equipped with the Martin *Mace*, and negotiations are now in hand to acquire the Martin *Pershing* medium-range, surface-to-surface missile.

Aircraft

Major Robert White reached Mach 4.62 (corresponding to a speed of 3,074 m.p.h.) in the North American X-15 research aircraft on April 12th. The Thiokol-Reaction Motors XLR-99-M-1 engine fired at the second attempt, running for 67 seconds at full power. The maximum altitude reached was 105,100 ft. During the flight, which lasted eleven minutes, the X-15's skin was friction-heated to 700°F at certain points.

●

New data for the Potez-Air Fouga Magister trainer, powered by two Turboméca *Marboré VI* jets, each of 1,060 lb thrust. Span, including wing-tip tanks, 39.86 ft ; length 32.81 ft; height 9.19 ft; wing area 186.2 sq.ft.; empty weight 4,755 lb; gross weight 6,980 lb. Maximum speed in level flight at 23,000 ft altitude 440 m.p.h.; maximum speed in dive 535 m.p.h.; sea level rate of climb 3,640 ft/min; time-to-climb to 29,500 ft from release of brakes 13 minutes; service ceiling 44,300 ft; take-off roll 1,640 ft; range 815 miles with 26.4 Imp.gal. fuel reserves.

Electronic Programme for the European Starfighter

Cf. article on page 553

SYSTEM	FEDERAL GERMANY	NETHERLANDS	BELGIUM	ITALY
1. Inertial navigation system	Litton GmbH	Monroe N.V.	Bell Telephone Manufacturing	–
2. NASARR navigation and fire control system	Telefunken GmbH	Hollandse Signaalapparaten	Manufacture Belge de Lampes et de Matériel Electronique	Fabbrica Italiana Apparecchi Radio
3. Flight director	Honeywell GmbH	–	Ateliers de Constructions Electriques de Charleroi	–
4. Position and homing indicator	Teldix-Luftfahrtausrüstungs GmbH	–	–	Ottico Meccanica Italiana
5. Flight data computer	Interaero GmbH	–	Bell Telephone Manufacturing	–
6. Toss-bomb computer	–	Hollandse Signaalapparaten	–	?
7. Optical equipment	Allgemeine Elektrizitätsgesellschaft AEG		Soc. Belge d'Optique et d'Instruments de Précision	–
8. Range computer	Allgemeine Elektrizitätsgesellschaft AEG	–	–	–
9. TACAN navigation system	Standard Elektrik Lorenz	–	–	Face-Standard S.p.A.
10. Infra-red homing equipment	Eltro GmbH	Onde Delft	–	–
11. Collins Arc 552 UHF radio	–	Van de Heem	–	–
12. APX 46 IFF	Siemens & Halske	–	–	–

Armstrong Whitworth Aircraft (HSG) announces a project for a double-decker freight/passenger aircraft, based on its two years' experience of flying with the AW.650 *Argosy*. Two versions, the *Air Ferry* and the *Airbus*, will be developments of the AW.670. The *Air Ferry* will be able to transport eight cars on its lower deck and up to 32 passengers on its upper deck, while the *Airbus* version will carry up to 114 passengers. With a payload of 25,000 lb the *Air Ferry* will have a range (including reserves) of 140 n.m., at a cruising speed of 240 m.p.h. The *Airbus* will be able to transport 20,000 lb over 350 n.m. at a cruising speed of 270 m.p.h.

●

Data on the new Hiller 12-E4 four-seat helicopter of all-metal semi-monocoque construction (cf picture on page 706) are as follows : fuselage width 5 ft ; fuselage length 29.8 ft ; height to rotor head 9.8 ft ; cabin maximum interior width 4.9 ft. The Lycoming VO-540 dual-carburettor engine is rated at 305 h.p. at sea level and a speed of 3,200 r.p.m.; it drives the two-blade main rotor (diameter 35.4 ft) and the two-blade tail rotor (diameter 5.5 ft). Empty weight 1,775 lb; useful load 975 lb; gross weight 2,750 lb. The cruising speed is given as 90 m.p.h.; sea-level range 225 miles. Vertical rate of climb 820 ft/min ; maximum rate of climb 1,340 ft/min. Service ceiling 15,600 ft ; hover ceiling in ground effect 10,000 ft ; hover ceiling outside ground effect 6,400 ft.

●

Hindustan Aircraft Ltd., Bangalore, is pushing ahead with the construction of the prototype of a new basic jet trainer for the Indian Air Force, designated HJT-16 Mk.II. The trainer should make its first flight early in 1962.

Powerplants

During tests of a liquid-cooled Rocketdyne F-1 combustion chamber at Edwards, California, on April 6th, a record thrust of 1,640,000 lb was obtained. The firing was sustained for 13 seconds. The F-1 single-chamber rocket engine, designed for large booster vehicles and developed by Rocketdyne Division of North American Aviation Inc. under the technical direction of the NASA George C. Marshall Space Flight Center, is rated at 1,500,000 lb and is scheduled to become operational between 1963 and 1965.

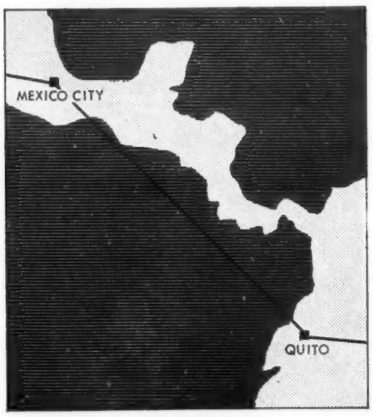
●

The Pratt & Whitney JT8D-1 turbofan engine chosen for the Boeing 727 was scheduled to begin static tests at the end of last month and will be fitted to a North American B-45 for flight tests later this year. Prototypes of the engine, which has a take-off rating of 14,000 lb, will be sent to Boeing in 1962 for testing the 727 airframe. Delivery of production engines will begin in the first half of 1963. The JT8D-1, which has a thirteen-stage compressor and a four-stage turbine, weighs 2,988 lb. Its maximum diameter is 42.5 in., its length 122.5 in.

Photo credits : Cover picture : Ministère des Armées "Air" p. 535 : manufacturers (1) ; p. 592 : Interavia drawing (1) ; pp. 597-609 : manufacturers (35), Interavia drawings (4), Interavia (4) ; pp. 610-612 : Interavia files (2), manufacturers (2) ; pp. 619-644 : manufacturers (30) ; pp. 645-650 : manufacturers (9) ; pp. 667-676 : manufacturers (12), manufacturers' drawings (14), U.S. Navy (2), Howard Levy (1), p. 677 : manufacturers (4) ; pp. 678-679 : M.E.A. (5); Charles Brown (1) ; pp. 680-681 : manufacturers (6), Interavia drawing (1), National Research Council, Canada (1) ; p. 682 : manufacturers (2) ; p. 699 : manufacturers (2) ; p. 701 : manufacturers (1) ; pp. 702-703 : manufacturers (4) ; pp. 704-706 : manufacturers (7), Stuttgart Airport (1) ; p. 707 : NASA (3), manufacturers (1) ; pp. 708-709: Interavia files (3).

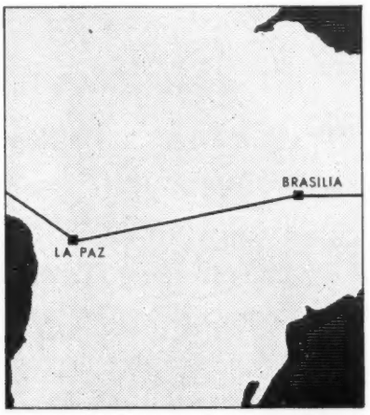
Versatility of the de Havilland Comet

The Comets are operating profitably on world routes in widely different conditions of traffic, airfield length, temperature and altitude. No other jet airliner can serve short, medium and medium-long stages and give high frequency with economy even where the traffic density is only moderate. These maps show examples of stages which, despite difficult airfield conditions, can be operated by the Comet, in both directions, without payload restriction.



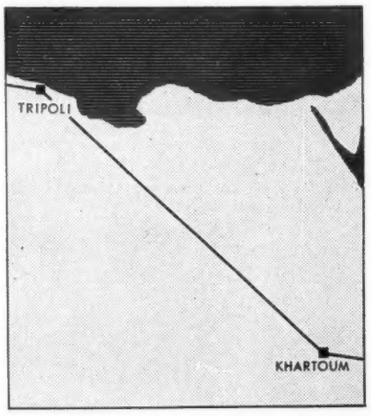
ROUTE 1

Airport	Mexico City	Quito
Height above MSL, feet	7,340	9,243
Mean daily max. temp. for hottest month °C	26	23
Runway length feet	11,200	9,020
Distance	2,235 st. miles	



ROUTE 2

Airport	Brasilia	La Paz
Height above MSL, feet	3,473	13,402
Mean daily max. temp. for hottest month °C	27	12
Runway length feet	7,874	11,087
Distance	1,310 st. miles	



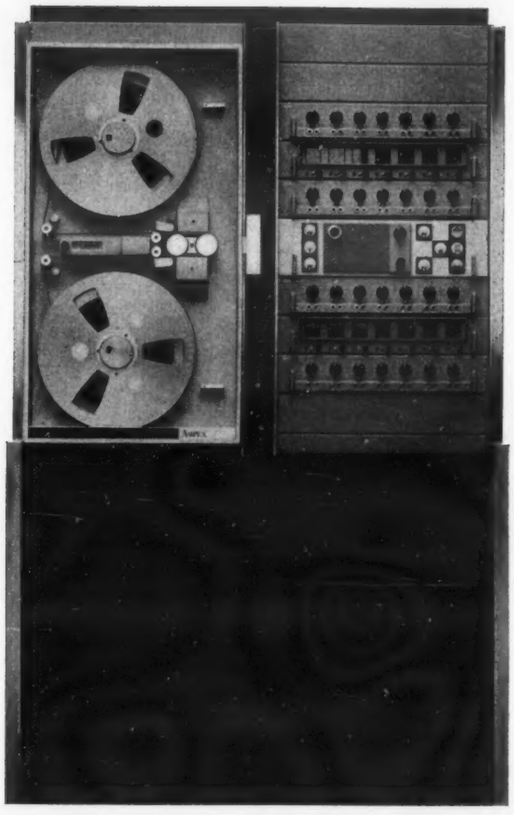
ROUTE 3

Airport	Tripoli	Khartoum
Height above MSL, feet	263	1,253
Mean daily max. temp. for hottest month °C	37	42
Runway length feet	7,305	7,050
Distance	1,695 st. miles	

The Comet fits the routes — and increases the profits

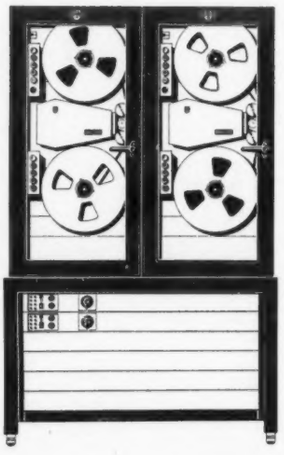
HAWKER SIDDELEY AVIATION

The AMPEX CP-100 is a compact, extended-frequency instrumentation tape recorder/reproducer. Tape transport, motor drive amplifier, heads, power converter, controls and all-transistorized plug-in record/reproduce electronics are contained in a single 13¼" x 19" x 33¼" mobile case. The CP-100 operates on 28-volt DC, with 48 to 400 cycle converters available for other power sources. Data is recorded by direct or FM carrier techniques on up to 14 analogue tracks. The CP-100 offers frequency response to 200 Kc at 60 ips or expanded recording time of 24 minutes for 100 Kc data at 30 ips on a standard 10½" reel. Transport tape speeds – 1⅞, 3¾, 7½, 15, 30 and 60 ips – and plug in frequency determining units and equalizers associated with tape speeds, may be quickly changed. The versatile and mobile CP-100 performs reliably over a temperature range of from −50° F to +160° F, up to an altitude of 10,000 feet, in relative humidities to 95%... and is designed to withstand shocks and vibrations encountered in rugged mobile testing applications. This recorder may also be rack mounted if desired. For complete details write Redwood City Engineering Ltd., Arkwright Road, Reading, Berks., England. AMPEX

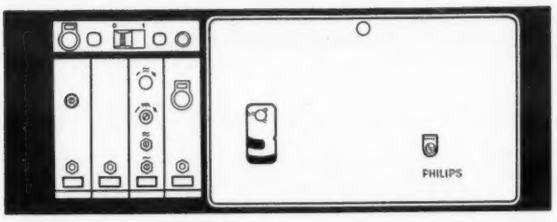


The AMPEX FR-600 is an advanced-design data recorder with twice the capacity of conventional recorders. Most analogue recorders can only record 24 minutes of 100 Kc data on a 14-inch reel of 1 mil tape. The FR-600 will record 48 minutes of the same data on the same reel of tape. The reason – greater bandwidth at a given speed ... 125 Kc at 30 ips, for example. Many data-runs are 30 minutes or longer, requiring a stand-by recorder to pick up where the first leaves off ... an expensive price for a few extra minutes of recording time. The FR-600 literally does the work of two conventional machines by enabling double record time for any given bandwidth, or double bandwidth for any given record time ... 250 Kc at 60 ips, for example. Another cost-saving feature is the tape shuttle which automatically scans any portion of the tape, eliminating the need for a separate loop recorder. Modular plug-in, solid-state electronics warm up in less than 10 minutes, and FM amplifier drift is less than one percent in 24 hours. Other advanced features of the FR-600 include pneumatic tape guiding, tension sensing and control, adjustable search speed and fourteen miniature monitor oscilloscopes. For complete information write Ampex Great Britain Limited, Arkwright Road, Reading, Berkshire, England. AMPEX

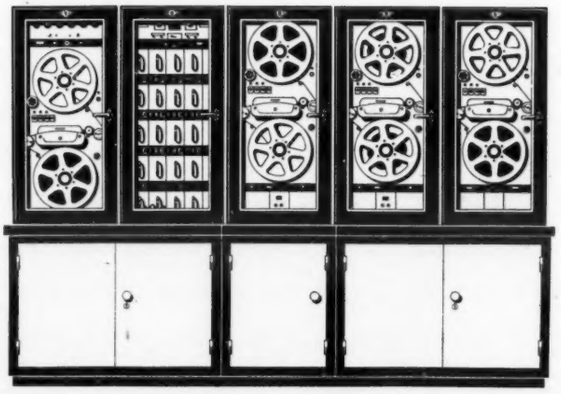
recording for aviation



Radar Recording System consisting of a **bandwidth compression unit**, a **recorder** capable of magnetic storage of ATC radar information and relevant communications during any period up to 12 hours of unattended operation, and a **display console** for reproduction of the recorded radar information.



Weather Information Repeater for automatic ground-to-air dissemination of meteorological data as recommended by ICAO - a repeater system utilizing no more than 6 weather information repeaters will cover the requirements of most airports and reduce operating time to a minimum.
For 19-in. rack mounting.



Fifteen-Channel Magnetic Recording Equipment capable of unattended, round-the-clock registration of all ATC communications, complete with **separate playback equipment.**

PHILIPS

airfield lighting - electronic measuring and control equipment - high power amplifiers - multichannel recorders/reproducers - public address systems - radar recording systems - weather information repeaters - telecommunication equipment and radar systems.

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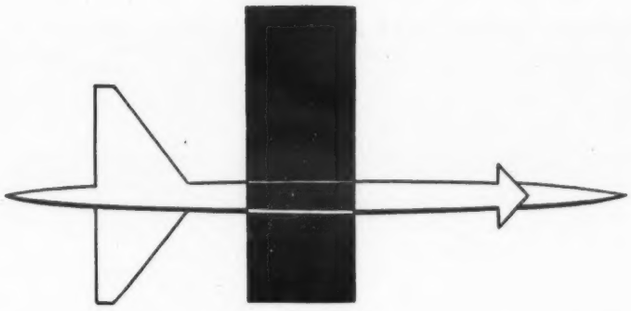
ZDO



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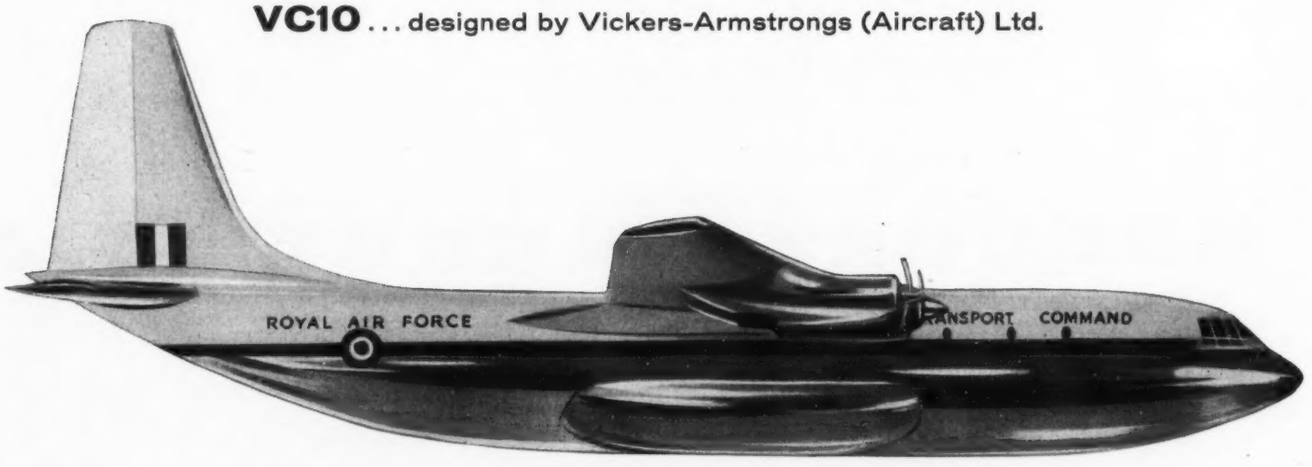
D.H.121-TRIDENT ... designed by de Havilland Aircraft Co. Ltd.

VC10 ... designed by Vickers-Armstrongs (Aircraft) Ltd.



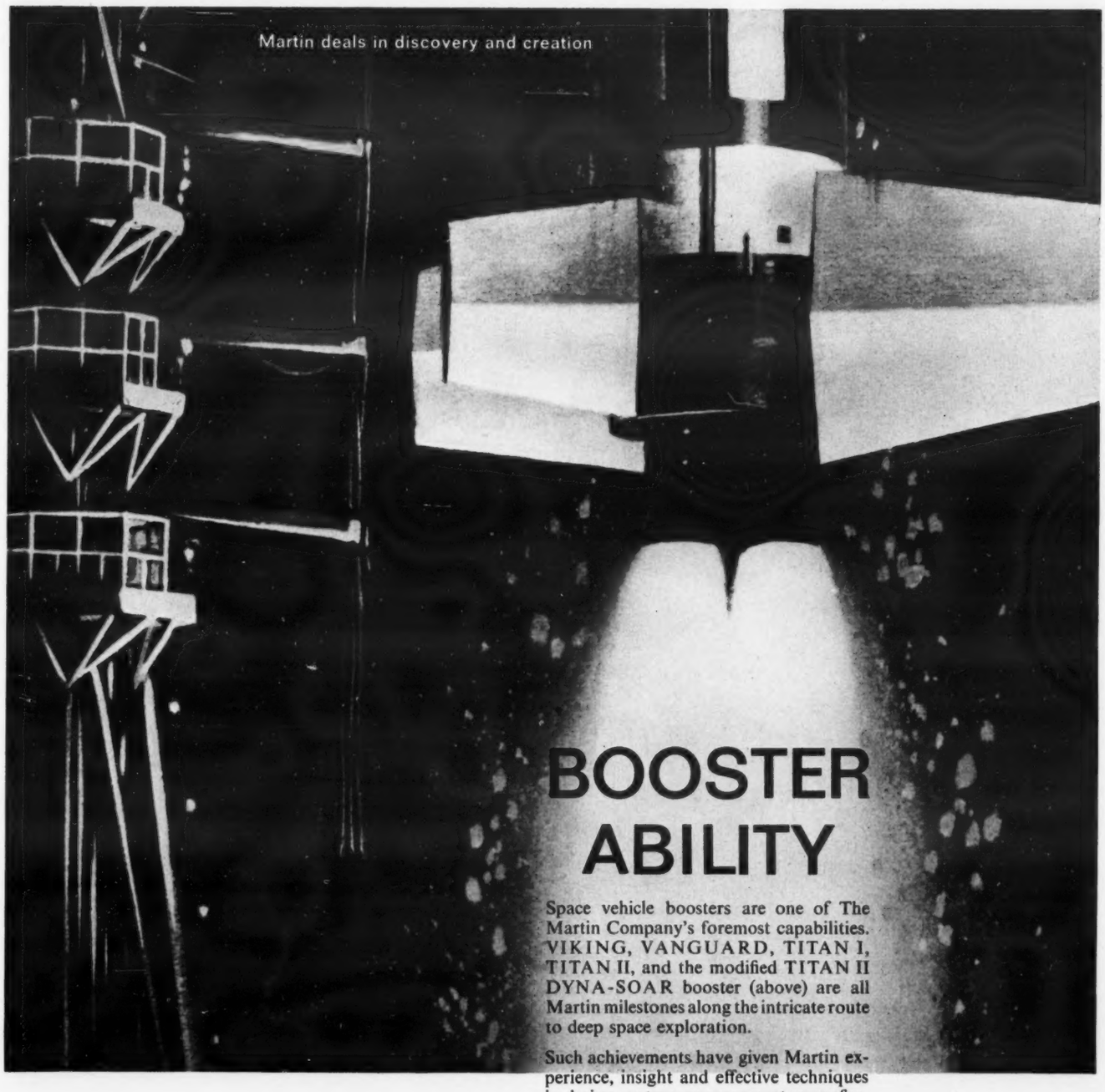
S.C.5-BELFAST ... designed by Short Brothers & Harland Ltd.

Dunlop tyres, wheels, brakes, and operating equipment have been chosen for these aeroplanes. Thus yet again Dunlop are closely associated with a new generation of high-performance British Aircraft.

DUNLOP

DUNLOP RUBBER COMPANY LTD., AVIATION DIVISION, FOLESHILL, COVENTRY

HCD18/AV



BOOSTER ABILITY

Space vehicle boosters are one of The Martin Company's foremost capabilities. VIKING, VANGUARD, TITAN I, TITAN II, and the modified TITAN II DYNA-SOAR booster (above) are all Martin milestones along the intricate route to deep space exploration.

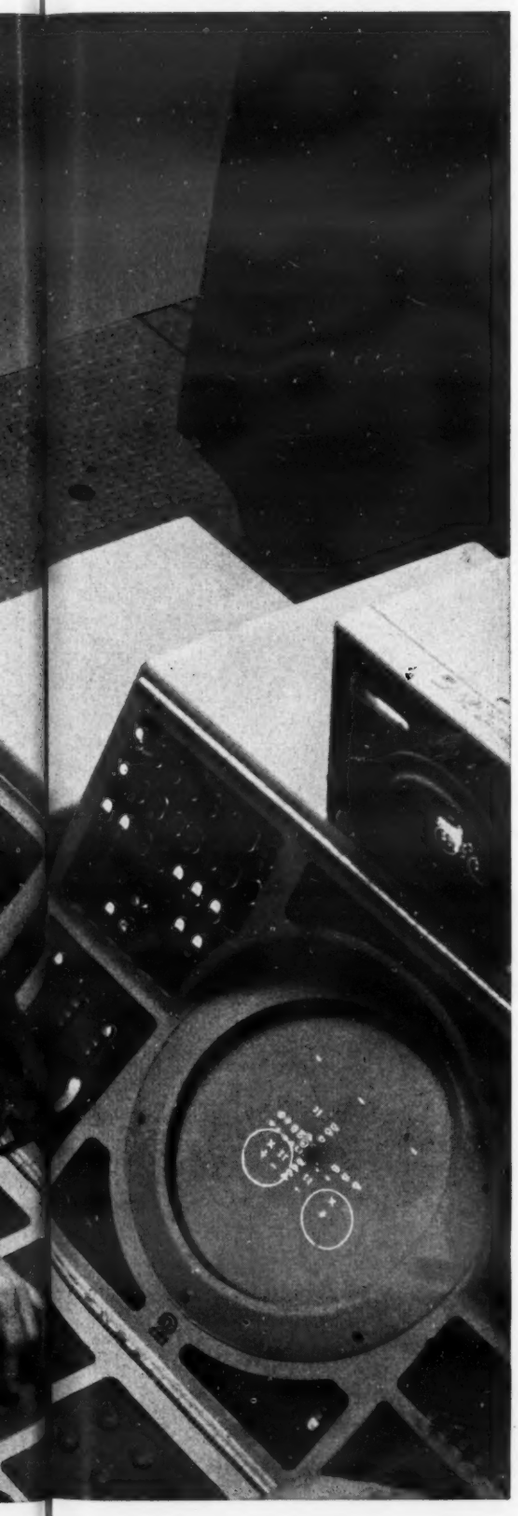
Such achievements have given Martin experience, insight and effective techniques in design, systems management, manufacturing and testing. They have led and will lead to the development of even greater booster capabilities.

Martin is active in many areas of space research: space flight vehicles, manned satellites, nuclear rockets, thermoelectric power generation, guidance systems, thermal shield materials, interplanetary communications, and the life sciences.

You are invited to visit Booth 54 in the XXIV Salon International de l'Aéronautique at Le Bourget, May 26 to June 4, where many of Martin's current weapons systems will be on display. Representative space age projects will also be exhibited.

MARTIN

How to read an enemy mind



Today, Navy battle commanders can predict where an enemy will be next.

Deep in the control room of a giant carrier, they see the enemy deploy. They watch the entire tactical situation—every movement of every ship, aircraft and submarine in the battle area.

Their "eyes" are new Hughes Display Consoles. These TV-like consoles present the over-all situation in quick pictorial form.

The consoles are part of a complete system which also analyzes the enemy's movements and gives split-second recommendations for countermoves.

With this information commanders can coordinate defensive task force movements and assign weapons with unprecedented speed and precision.

Soon to be installed on carriers and guided missile ships, the complete Naval Tactical Data System includes the Hughes consoles, a high-speed computer and radio and data transmission equipment.

Other surface systems at Hughes include development of new types of computers, circuitry and memory cores. Still other projects are expanding on the Hughes 3-D (electronic scanning) radar principle—one of the major breakthroughs in the electronic arts.

Electronics is our business. Over 5,000 Hughes engineers and scientists constantly search for the best ways to do jobs never done before—for new ways to do old jobs better. Your problem may be an opportunity for both of us.

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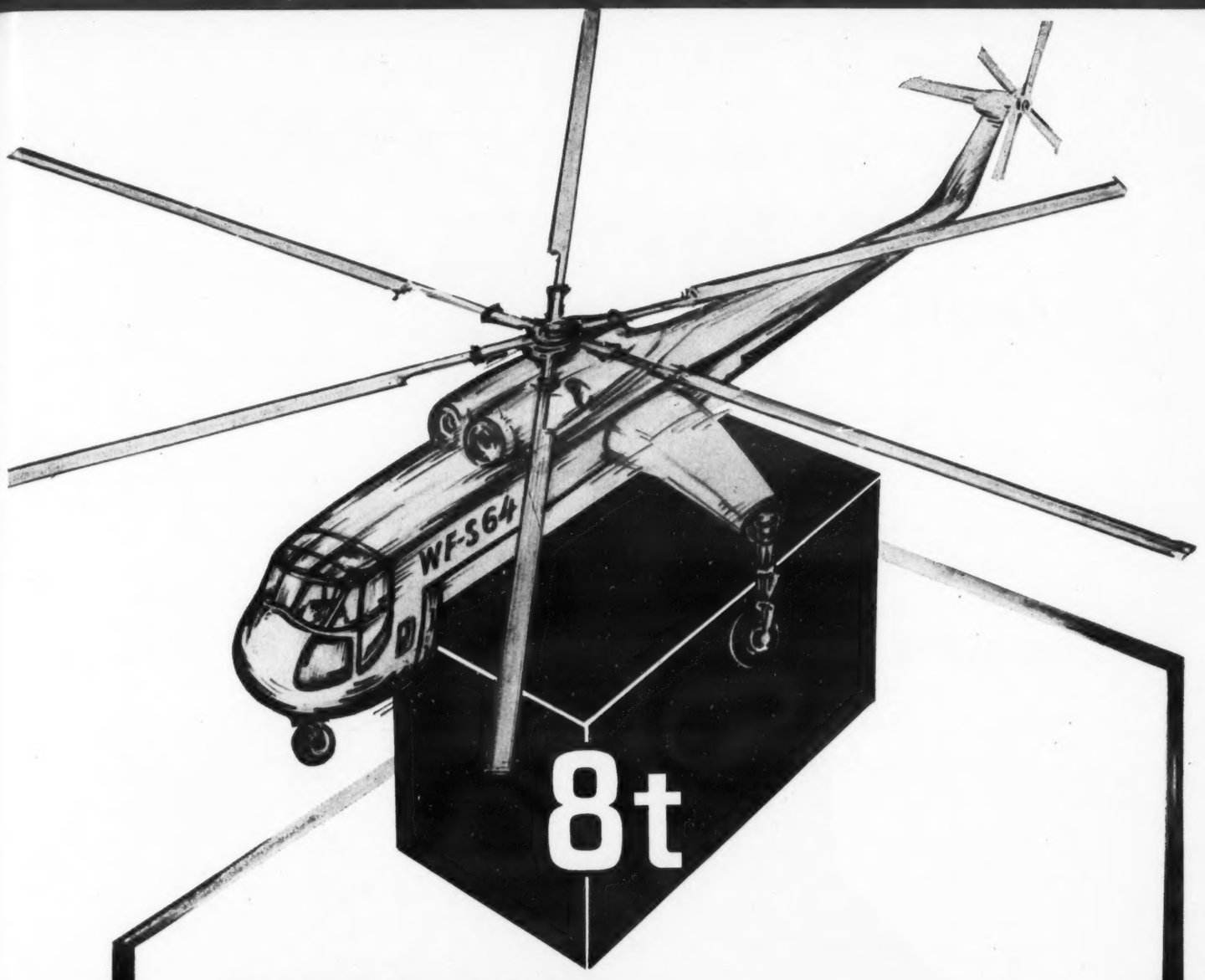

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Coblenz – Nerve Centre of the European Starfighter Construction Programme

The choice of the American Lockheed F-104G *Starfighter* multi-purpose single-seat combat aircraft by the German Air Force Staff and the Federal Technical and Purchasing Office in October, 1958, was the starting signal for the largest inter-European aircraft procurement programme so far undertaken. *Interavia* has contained many reports on the development history of the "European" F-104 and the preliminary preparations for the construction programme, most notably in the April and June issues of last year. Now that certain aspects relating to military policy and industry have come under discussion, it may be of interest to describe the activities of the Organisme de Direction et de Contrôle in Coblenz, which is the hub of the F-104 programme.

The creation of the ODC dates back to March 5th, 1960, when the Defence Ministers of the German Federal Republic, Belgium and the Netherlands signed an agreement to this effect at Cologne-Wahn Airport. Coblenz was chosen as the headquarters of the organization, at it is also the headquarters of the Federal Technical and Purchasing Office, which had been carrying out preliminary work on the programme ever since the selection of the F-104 by the German Air Force. The ODC started work in mid-1960. First, a precise time and production sharing schedule had to be drawn up, stating what parts of the aircraft could be built with plant already available, and where and in what quantity new plant was to be provided for the construction of the F-104. After organizational difficulties had been overcome, many of the production questions affecting airframe and engines could be settled. The time and production sharing schedule for the manufacture of the twelve electronic systems constituted a far more difficult problem, in that most of the systems involved were either new or still under development. By mid-November, 1960, however, agreement had been reached between the States concerned regarding the broad outline of the programme to be followed.

At this time Italy became the fourth associate in the European *Starfighter* programme. This meant that all the production quotas, including that for electronics, had to be redistributed, thereby causing fresh delays in the preparations. These, however, are not expected to influence the total duration of the programme, but only the date when the production peak of over 30 aircraft per month is reached. The Congo crisis also had an unfavourable effect, as it held up the preliminary work of the Western Group (Fairey/SABCA). This delay pointed to the necessity for linking Fiat with the Western Group, and the final arrangements for allocating quotas for airframe, engines and electronic equipment could at last be made. The following table gives a survey of the airframe production programme.

Suppliers	For the Air Forces of				No. to be built by each supplier
	Germany	Belgium	Holland	Italy	
Lockheed USA	126				126
Arge Süd	210				210
Arge Nord	255		95		350
Fairey/SABCA	89	75			164 *
Fiat	50	25	25	125	225 **
Total per Air Force	730	100	120	125	1,075 ***

* Fairey/SABCA and Fiat share final assembly for each group
** 194 F-104Gs will be assembled in Belgium and 195 in Italy.
*** of which 949 aircraft are to be built in Europe.

The licence production of a total 1,039 engines is shared between BMW, FN and Fiat, though the exact quotas have not yet been fixed. As the engines must be delivered to the airframe manufacturer four months before the final assembly of each aircraft, certain difficulties in meeting schedules are expected.

The table on page 536 shows how the licence production of the twelve electronic systems for the F-104 is shared. These must be delivered to the company responsible for final assembly at least six months before each aircraft is assembled. A total of 949 sets of electronic equipment, corresponding to the number of European-built *Starfighters*, are to be produced, with 869 being built in Europe and 80 in the USA. No information has yet been published regarding the programme for the remaining aircraft equipment, ground support equipment or spares.

★

To return to Coblenz, the Organisme de Direction et de Contrôle, to give it its official French title, consists of two non-permanent committees on which the Defence Ministers and the purchasing commissions of the four States concerned are represented. Under these committees is a permanent committee headed by Colonel H. K. Stokla (Netherlands), whose members are Colonel Scholz (Federal Republic), Colonel E. Rulmond (Belgium) and Colonel Noto (Italy). The permanent committee is assisted by a staff responsible for central planning, technical coordination and general administration. The committee controls four main departments: 1. airframe and engines; 2. electronics and ground equipment; 3. logistics; 4. contract department. Each of these four main departments is divided into sub-departments: *Airframe and engines*—aircraft and systems, production (including safety devices and ejection seats), engines and accessories; *electronics and ground equipment*—fire control and armament, navigation and simulators, basic equipment; *logistics*—spare parts, acceptance control, documentation; *contract department*—costing, delivery control, licensing, taxes, duties and transport.

Parallel with the ODC, the California Division of Lockheed Aircraft Corp. has set up an advisory organization, headed by the F-104 European Director, J. B. Pitkin, also with headquarters in Coblenz. This organization maintains direct contact with all States concerned in the licence production of the F-104, including Canada and Japan. It was considered advisable that the two latter countries should participate in ODC in some way, as they are already taking part in the discussions on modifications.

★

The following information received by *Interavia* in recent months gives a picture of the state of the European F-104 programme.

Bonn, February 9th, 1961: Preparations for F-104G licence production in West Germany are well advanced, according to the Defence Ministry.

The Arge Süd Group has completed tooling and started producing first components last October. The first roll-out, largely with U. S.-supplied components, is expected in November or December this year, and production should reach a level of six aircraft a month by the end of 1962. The Arge Nord Group will begin production of components this month, and first roll-out, again largely from U. S. components, is expected by spring 1963.

Amsterdam, March 21st, 1961: Fokker is building up a subcontractor and supplier organization in preparation for European F-104G production. Companies include Wilton (Netherlands)—main landing gears; Cramic Co. (U. K.)—tools and machines for machining wing skins; Onde Delft (Netherlands)—infra-red homing equipment; Philips (Netherlands)—NASARR navigation and fire control system; Van der Heem (Netherlands)—radio equipment. Fokker will be responsible for final assembly and the construction of aircraft radomes.

Milan, February 20th, 1961: The representatives of firms manufacturing aircraft and maintenance equipment for the Lockheed F-104G have met in Milan at the offices of the Associazione Industrie Aeromissilistiche to set up a committee to coordinate Italian Lockheed F-104G production within the framework of the European *Starfighter* programme.

There is no space in the present article to mention all the firms involved in the European *Starfighter* programme, but a visit to the Paris International Air Show will undoubtedly complete the picture.

Good Market Prospects for Ligth and Business Aircraf:

Over a Dozen Projects at Le Bourget

Even in the age of rockets and space flight, new projects for light aircraft of all kinds are continually taking shape. In the field of the business aircraft, development activity has, in fact, intensified. One has only to think of the new models produced by the American firms of Beech, Cessna and Piper and by the French company Morane-Saulnier, all of which will be on show at Paris. The British Beagle company, which had previously maintained a discreet silence, announced its intentions shortly before the Air Show of producing a four-seat piston-engine touring aircraft with tricycle undercarriage. The Swedish firm Svenska Aeroplan AB will show a model of the Saab 105 twin-jet business aircraft, and Potez-Air Fouga and Heinkel will present a new four-seat jet aircraft. De Havilland is expected to give details of a radically new design, the DH.125 *Jet Dragon* touring aircraft. A new partnership, Douglas and Piaggio, will present the six-seat, twin-jet PD-808, a joint development.

Although in the case of the last four aircraft some reservations must be made in using the term " light," since their all-up weights lie between four and eight tons, it is possible to stretch a point in view of the general increase in all-up weights in all aircraft categories (up to 100 tons for medium-range airliners !). The editors hope that the designers of the Hurel-Dubois HD.130, mentioned in this article, will not take it amiss if their projected five-ton transport is classified as a "light" aircraft.

The following is a telegraphic review of some of the aircraft projects and prototypes which will be presented for the first time at Le Bourget ; further models will be dealt with in the retrospective survey of the Paris Show.

Beagle-Auster Airedale touring aircraft

British Executive and General Aviation Limited (Beagle), founded at the end of last year, is reportedly working on a number of aircraft projects, details of which have so far been withheld. The firm has, however, published information on the Beagle-Auster A 109 *Airedale* project for a four-seat touring aircraft, which offers an interesting comparison with other touring models of this class on the market today.

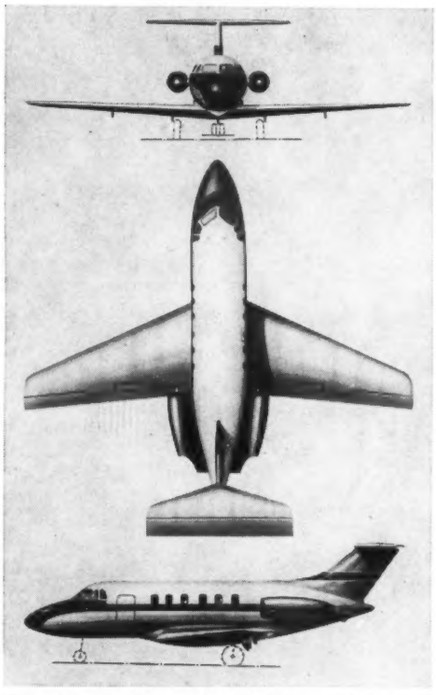
The *Airedale* is powered by an air-cooled 180 h.p. Lycoming O-360-A1A flat-four engine with constant-speed two-blade variable-pitch propeller. Span is 36 ft, length 25 ft 10 in. and height 9 ft 1 in. At a maximum all-up weight of 2,750 lb, the *Airedale* can carry a useful load of 1,120 lb, i.e. a pilot, three passengers and baggage weighing 780 lb, plus 52 Imp.gal. fuel. The following design performance has been calculated for an all-up weight of 2,650 lb : Maximum speed at 1,000 ft 140 m.p.h. ; maximum cruising speed at 5,000 ft 130 m.p.h. ; economical cruising speed at 7,500 ft 125 m.p.h. ; fuel consumption 6.5 gal/h. With a payload of 780 lb the economical cruise range is 600 miles, and 970 miles with a payload of 700 lb and full fuel reserves. Take-off distance over a 50 ft screen is quoted as 595 yd, and landing distance as 425 yd.

Bölkow F-207 four-seat tourer

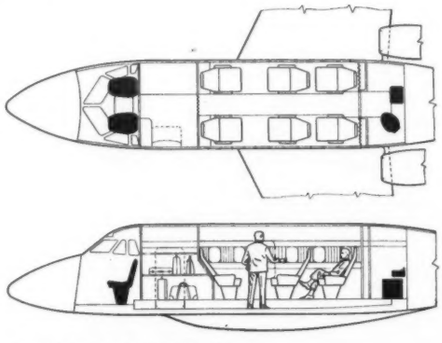
Bölkow-Entwicklungen KG, Ottobrunn, Munich, has been conducting extensive research into the market for a four-seat touring aircraft, and has quietly and unobtrusively been developing a model which will be sold under the designation Bö F-207 and which will be demonstrated in flight at Paris. The F-207, which corresponds to the international standards for business aircraft, is the first four-seater of its class to be built and produced in post-war Germany. The cabin equipment and instrumentation feature many innovations, and when a sales organization has been set up the company hopes to secure a reasonable share of the touring aircraft market. A new facility has been built at Laupheim, near Ulm, to enable the aircraft to be built in sufficient quantity.

The F-207 is a low-wing aircraft of wooden construction, making considerable use of plastics. The one-piece wing with a single spar is easily removable for surface transport. The aircraft is powered by a 180 h.p. Lycoming engine of the O-360 series. The wing roots contain two fuel tanks, each with 22 Imp.gal. capacity ; two wing-tip tanks, each with 11 gal. capacity, are available as optional equipment. With two seats the F-207 can be used as a trainer and for limited aerobatics (utility category) and with one seat for unlimited aerobatics (acrobatic category). A combined wheel/ski undercarriage is provided, together with an attachment for towing banners and sailplanes.

Main data : span 35.5 ft ; length 27.2 ft ; height 7.4 ft ; wing area 165.8 sq. ft. ; weight equipped 1,540 lb ; gross weight 2,645 lb ; wing loading 15.98 lb/sq. ft. ; maximum speed 137 knots ; landing speed 45 knots ; service ceiling 16,400 ft ; range at economic power 700 n.m. ; fuel consumption at economic power 8.9 Imp. gal./h ; take-off roll in still air 1,030 ft ; landing roll 920 ft.



Three-view drawing of the de Havilland DH.125 jet touring aircraft.

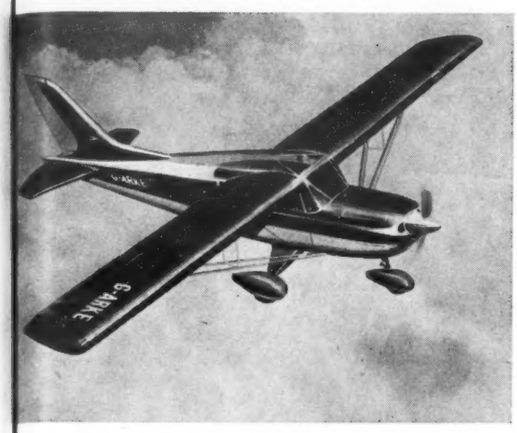


Seating layout of the DH. 125.

De Havilland DH.125 business aircraft

For months London aviation circles have been talking of a new business aircraft under development by de Havilland. Now the company is offering this twin-jet model for six to eight passengers under the designation DH.125 *Jet Dragon*, pointing out that it can also be used for military applications. The two rear-mounted Bristol Siddeley *Viper 20* engines (3,000 lb thrust each) enable the aircraft to attain speeds of between 450 and 500 m.p.h. at ranges of up to 1,500 miles, giving it a take-off

The PD-808, developed by Douglas, to be built by Piaggio.



Beagle-Auster A 109 *Airedale*.

performance which will permit it to operate from any large airport. Technical data: Maximum all-up weight 18,000 lb; span 44 ft; length 43.5 ft; cabin width 5 ft 10 in.; cabin height 5 ft 9 in.; wing area 342 sq.ft. The range of 1,500 miles mentioned above allows for normal fuel reserves, which are adequate for visual flying conditions.

De Havilland will initially build a batch of 30 aircraft, and the prototype is expected to fly as early as next year. Under present plans, the first production models will be available in 1963. With the DH.125 project, Hawker Siddeley Aircraft is yet again affirming its intention to further strengthen its position on the world civil aircraft market. Nor does the British aviation concern shrink from incurring development costs which no individual manufacturer would have risked a few years ago. Even the relatively small DH.125 will require investments of several million pounds, which points to the likelihood of a vigorous sales campaign.

Douglas-Piaggio PD-808

In April this year Douglas and Piaggio signed an agreement for the construction of a six-seat jet touring aircraft, to be developed by the Douglas Aircraft Company's El Segundo Division and produced by Piaggio with the aid of its American partner. Under the agreement, two prototypes will be built, with the first beginning flight tests in 1962. The Italian Air Force is reportedly showing keen interest in the project.

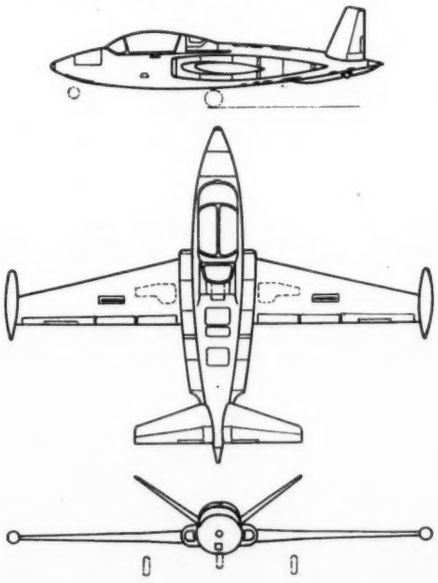
As the accompanying picture shows, the PD-808 is a low-wing aircraft with two rear-mounted jet engines (3,000 lb thrust), designed to cruise at 500 m.p.h. and altitudes of around 40,000 ft. The Douglas El Segundo Division has already completed design work, and Piaggio will be responsible for preparing drawings and tooling, with assistance from Douglas. Douglas has secured sales and customer service rights for the PD-808 all over the world, with the exception of Italy and certain other European countries. In addition, the American concern has the right to build the aircraft for the U.S. Air Force if an official order is received.

Potez-Heinkel CM.191

As early as 1958, Potez-Air Fouga presented the West German firms engaged in licence production of the *Magister* jet trainer with a proposal for the joint development of the aircraft to a four-seat tourer. Development work, which has been mainly shared with Ernst Heinkel Flugzeugbau GmbH, Speyer, is now complete, and a prototype of the aircraft, which will be offered under the designation Potez-Heinkel CM.191, will receive a public demonstration at the Paris Air Show. The manufacturers stress that the CM.191 can be used not only as a business aircraft, but also as a feeder or sports aircraft, a trainer for conversion to jets and for advanced training, for blind flying and navigational training and for reconnaissance purposes. Like the *Magister*, the CM.191 is an all-metal mid-wing aircraft with a butterfly tail. The trapezoidal wing, of single-spar construction, has Fowler flaps and statically and aerodynamically balanced ailerons. The monocoque fuselage of the prototype is fitted with two Turboméca *Marboré VI* jet engines, each delivering 1,056 lb thrust, but more powerful engines could be installed later, if required. With a span of 39.4 ft and a length of 32.8 ft, the CM.191 has an equipped weight of 4,520 lb. The following table gives further technical data.

	Without external tanks	External wing tanks 2 × 51 gal.
Take-off weight	8,475 lb	9,400 lb
Fuel weight (total)	2,502 lb	3,318 lb
Fuel in external tanks	—	816 lb
Max. speed at average all-up weight and 22,600 r.p.m.	435 m.p.h.	410 m.p.h.
Ceiling at 200ft/min rate of climb and 22,600 r.p.m.	35,760 ft	34,120 ft
Rate of climb at take-off weight and 22,600 r.p.m.	2,890 ft/min	2,480 ft/min
Time-to-climb to 23,000 ft	12.9 min	15 min
Take-off roll	2,740 ft	3,494 ft
Range at 30,000 ft altitude with allowance for climband descent	975 mi	1,320 mi
Endurance at 30,000 ft at average speed of 310 m.p.h.	2.58 h	3.65 h

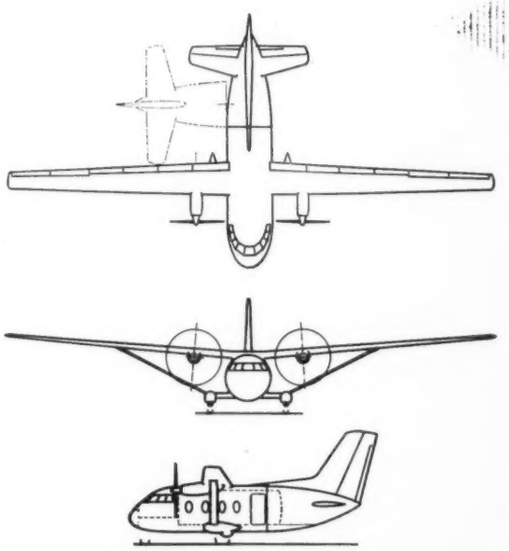
Potez-Heinkel CM.191 four-seat jet touring aircraft.



For longer ranges of up to 1,635 miles with an endurance of 4.65 hours, the aircraft can be equipped as a two-seater with extra fuel tank in the place of the other two passenger seats.

Hurel-Dubois HD.130 multi-purpose aircraft

Continuing the line which it adopted some years ago, namely the development of narrow, high aspect-ratio wings, Hurel-Dubois is engaged on a project for a freight and passenger aircraft to carry a 4,000 lb payload. Powered by two 530 s.h.p. Turboméca *Astazou II* propeller turbines, the high-wing model, designated HD.130, can also be used for aerial photography, ore and oil prospecting, agricultural operations, ambulance services and other special tasks.



Hurel-Dubois HD.130 small transport aircraft.

In addition to the typical Hurel-Dubois wing, the HD.130 is characterized by a swing tail and a freight hold 15.67 ft long, 7.42 ft wide and 5.28 ft high. Fitted with a pressure cabin, it can operate at altitudes of around 20,000 ft and cruising speeds of some 220 m.p.h. The tricycle undercarriage is specially designed for operations on unprepared runways, and the entire aircraft is designed for low-cost operation and minimum maintenance.

Data for the HD.130: span 85.8 ft; height 19.8 ft; external diameter of fuselage 7.9 ft; wing area 376.7 sq.ft.; aspect ratio 19.3. Empty weight 6,945 lb; payload for passenger version 3,806 lb; payload for freight version 3,923 lb; take-off weight of both versions 11,440 lb. At this weight the HD.130 requires a take-off roll of 1,120 ft and a take-off distance over a 50 ft screen of 1,571 ft; landing distance over 50 ft is 2,000 ft. A typical mission for the HD.130 might be as follows: flight at 10,000 ft altitude over a distance of 300 miles, with 2,816 lb payload, at an average cruising speed of 214 m.p.h., or flight at 20,000 ft over a distance of 600 miles at an average cruising speed of 220 m.p.h. and 2,244 lb payload. Both cases allow for 45 minutes fuel reserves.

INTERNATIONAL MEETINGS AND CONFERENCES

May 16th-18th: British Institute of Navigation, Institut Français de Navigation, Ausschuss für Funkortung, Radio Navigation Conference. Düsseldorf.

May 19th-June 4th: British Trade Fair. Sokolniki Park, Moscow.

May 20th-22nd: British Columbia Aviation Council, Spring Meeting. Nelson, B.C.

May 20th-June 3rd: Deutscher Aero Club, German Soaring Championships. Brunswick-Waggum Airport.

May 22nd-24th: National Telemetering Conference, sponsored by ARS, IAS, ISA, IRE and AIEE. Chicago, Ill.

May 22nd-26th: AGARD Structures and Materials Panel, Spring Meeting. Paris.

May 22nd-26th: Convention of the American Society of Tool and Manufacturing Engineers, with exposition of manufacturing equipment and engineering conference. New York.

May 25th-26th: Canadian Aeronautical Institute, Annual General Meeting. Toronto.

May 26th-27th: First Conference on the Peaceful Uses of Space, sponsored by NASA and the Tulsa Chamber of Commerce. Tulsa, Okla.

May 26th-June 4th: 24th International Air Show. Le Bourget Airport, Paris.

May 27th-28th: Touring Aircraft Rally, organized by the Royal Belgian Aero Club and the Association Nationale des Cercles Universitaires (ANCUPA). Bierset Airport, Liège.

May 30th-June 2nd: Radio and Electronic Component Manufacturers' Federation, 17th Radio and Electronic Component Show. London.

May 31st: IATA Executive Committee Meeting. New York.

June 3rd-5th: Aviation Distributors and Manufacturers Association, 37th Meeting. Atlantic City, N. J.

June 5th-9th: Ninth National Plastics Exposition, sponsored by the Society of the Plastics Industry, and SPI National Conference. New York.

June 12th-13th: Institute of Radio Engineers, Third National Symposium on Radio Frequency Interference. Washington, D. C.

June 13th-16th: Third International Symposium on Gas Chromatography. East Lansing, Mich.

June 13th-16th: Institute of the Aerospace Sciences and American Rocket Society, Combined National Technical Meeting. Los Angeles, Calif.

June 14th-15th: IRE, Fifth Annual Conference of the Professional Group on Product Engineering and Production. Philadelphia, Pa.

June 14th-17th: American Rocket Society, Semi-Annual Meeting. Los Angeles, Calif.

June 15th-18th: International Parachuting Contest organized by Fliegergruppe Leutkirch. Leutkirch, Bavaria.

June 15th-29th: Eighth International Congress of Electronics, Atomics, Television, Radio and Film. Rome.

June 16th-25th: Europlastica—International Plastics Fair. Ghent.

June 21st-25th: Fourth Round-Germany Flight, organized by the German Aero Club. Brunswick.

June 21st-July 1st: INTERPLAS 1961—International Plastics Exhibition and Convention. London.

June 26-July 1st: IMEKO 1961 (International Conference on Metrology and Instrument Construction). Budapest.

Round the World in..... 108 Minutes

MAN BROACHES SPACE

Although, early in April, there were already rumours that a Soviet astronaut was about to be launched into space, the world was more than surprised when, on April 12th, the Soviet news agency Tass announced that, for the first time, a manned space vehicle, the *Vostok*, had successfully circled the earth. Somewhere in the Soviet Union, in the early morning of that day (0607 hours GMT/0907 hours local time), a multi-stage rocket had been launched, weighing a few hundred tons and propelling the *Vostok* ("East") which, in its fully conditioned and copiously instrumented cabin, was to put Soviet Air Force Major Yuri Alekseievich Gagarin into orbit round the earth at an altitude of 125 to 185 miles.

The meagre details released by the Soviet authorities concerning this venture are well enough known from the daily press. The detailed appearance of Major Gagarin's space ship and the method of returning it to ground are, however, so far unknown. We have also been left in the dark about the pattern of the re-entry orbit, in the course of which *Vostok* passed through dense air layers and finally landed by parachute. Let us, however, once again follow the Soviet astronaut's probing flight on the basis of official releases.

When, after the burnout of the final stage rocket, the 10,400 lb space vehicle entered its pre-programmed orbit, Gagarin's hour of weightlessness began, a period which apparently had no ill-effects. Rushing through space at over 17,500 m.p.h. Gagarin reported over the R/T, barely 15 minutes after launching, that he was well. As he later confirmed at a press conference, the state of weightlessness interfered neither with the intake of his special rations nor with carrying out his tasks (in fact he was even able to take notes). As further reported by Tass, Gagarin was able, whilst in orbit round the earth, to observe the earth and the skies out of the special heat-resisting windows and through a periscope, with clear definition of seas, continents, mountains, and even rivers and large towns. Although the flight was conducted automatically, Gagarin had at his disposal means of influencing the control of the space vehicle and the timing of the start of the return operation. Apparently, however, everything went off according to plan and the direction of the entire operation was carried out from the ground.

Whilst the *Vostok* was approaching the South Atlantic from the Antarctic on its orbit (65° inclination to the equator), its re-entry into the earth's atmosphere was—according to Moscow radio—prepared at 0715 GMT by radio command signals from ground (possibly from Soviet observation vessels in the South Atlantic?) i.e. the *Vostok* was then brought into the position necessary for the braking operation to take place, whereupon at 0725 the braking rocket ignited. At this point, Gagarin was roughly over the Gulf of Guinea, close to the coast of Equatorial Africa. As programmed, the Soviet space vehicle left its orbit (perigee 113 miles, apogee 204 miles) and entered the denser atmosphere.¶ Exactly 30 minutes later, after covering another 5,000 miles, Gagarin landed somewhere in the western part of Soviet Russia.

It is gathered that, at a predetermined altitude, the space cabin containing the pilot was separated from the rest of the vehicle before being returned to ground by parachute. Moreover, the pilot was in an ejection seat which, had the necessity arisen, would have been ejected from the cabin at a great height (e.g. if, after a defective re-entry, the cabin had excessively overheated). The pilot himself was equipped with a space-suit for protection against loss of pressure in the cabin or the effects of premature ejection.

What configuration did the *Vostok* really have? According to Tass, the space vehicle consisted of two main components—the pilot's cabin and the remainder of the airframe. The latter contained not only the braking rocket and important parts of the automatic landing system, but also various measuring equipment. By separating the cabin from the rest of the airframe (which apparently burnt up at re-entry), the Soviet scientists were able to minimize the mass which required aerodynamic braking. The automatic cabin conditioning equipment maintained pressure inside the cabin as usual, kept the CO_2 concentration at a level not exceeding 1%, controlled the temperature at between 15° and 20° C, and kept relative humidity between 30 and 70 percent. Orientation was by bearings on the sun. By means of a TV transmission system, incorporating two cameras installed inside the cabin, it was possible to take front and side view photographs of the pilot and to read certain measurement instruments from the ground. The airborne transmitters for measurement data and for R/T communication worked on 9.019, 20.006 and 143.625 Mc/s.

As the Soviet newspaper Izvestia stressed in a long report on the space flight, even if the powerplant of the braking rocket had failed, Gagarin would have still been brought back to earth, as braking would have taken place in outer space as a gradual process. This would, of course, have taken several days, and sufficient food, water, life support equipment and battery capacity for ten days were provided on board.

It may also be of interest to inquire why the Russians limited the operation to one orbit round the earth, when several could have been achieved with the same technical effort. The reasons must lie in the fact that, after one orbit round the earth, the globe would have rotated so far to the East below the satellite's trajectory that, after a second orbit on his 65° trajectory, Gagarin would have landed not on Soviet territory, but somewhere in Europe or the North Atlantic. It would have taken about 18 orbits round the earth to reach a point where there would again be certainty of a landing on Soviet soil—which was moreover also the case with Space Vehicle II on August 19th, 1960. The whole *Vostok* experiment undoubtedly bears testimony to the complete confidence of Soviet scientists in their control and guidance systems. It must not, however, be forgotten that, by a systematic series of experiments, Sputnik II, Space Vehicle I and Space Vehicles II, III, IV, and V, the Russians have reached a state of knowledge which made Space Vehicle VI, the *Vostok* operation, considerably safer. As late as December 1st, 1960, the attempt to recover Space Vehicle III failed as a result of wrong positioning at the commencement of re-entry, and both the test equipment and the capsule containing the two dogs "Pchelka" and "Mouchka" burnt out on re-entry after the 18th orbit.

If the Russians persist in their strict silence about the decisive re-entry phase and about the *Vostok's* carrier rocket, this is surely because the whole concept is part of a military programme. It accordingly remains to be seen what consequences the Gagarin operation will have for the Western Powers' space weapon planning.

The vehicle shown in this photograph has a prototype cab and superstructure

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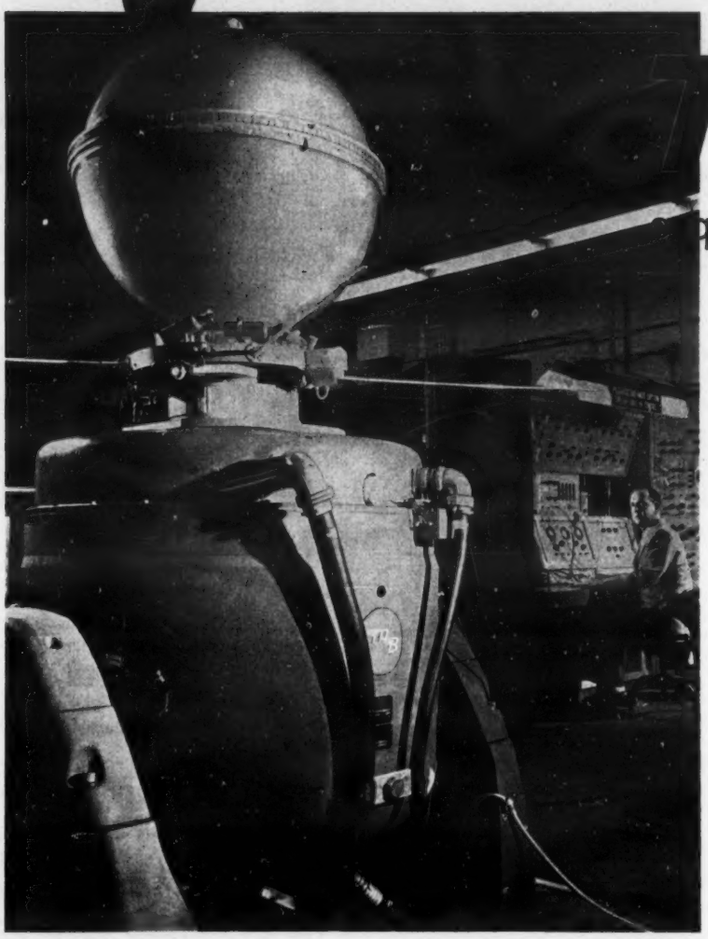

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Flight Propulsion NEWS

G-E Paris Air Show Theme : Aviation/Space Progress

Latest Propulsion Hardware Will Be On Display

PARIS, France—General Electric's Paris Air Show exhibits will place on public display the wide spectrum of the Company's aerospace achievements.

The General Electric stand will also feature a large array of G-E aviation and missile hardware, ranging from the Discoverer capsule to constant speed drives and cockpit instruments.

The J79 engine, G.E.'s Mach 2 turbojet that has powered four U.S. aircraft (Lockheed F-104, Convair B-58, North American A3J, McDonnell F4H) to 18 world speed and altitude records, will be shown in an exploded-display fashion. Another exhibit will feature the 3,850 lb. thrust class J85, which currently powers Northrop's T-38 supersonic trainer and N-156F fighter.

A large rotating exhibit will display the basic J79/CJ-805 gas generator in conjunction with its major components. These include afterburner, commercial sound suppressor and thrust reverser, the G-E aft turbofan, and a power turbine and exhaust system that converts the engine to turboshaft power for marine and industrial use.

The CJ-805-23 turbojet, G.E.'s commercial aft-fan engine now powering the Convair 990 and the Sud Caravelle VII, will be shown in full-scale cutaway. Full size models of the smaller CJ-610 and its aft-fan equivalent—the CF700—will also be included.

Turboshaft engines on display will include the T58 and T64 powerplants. Both are under active consideration in Europe as turbocopter drives.

Other displays will include hydraulic constant speed drives, and an exhibit of the several approaches to VTOL/STOL lift currently under development at General Electric.

G-E CARAVELLE NOISE LEVELS QUIETER BY SIGNIFICANT MARGIN

EDWARDS AFB, Calif.—Preliminary noise tests on the General Electric Caravelle have indicated its G-E CJ-805-23 aft-fan engines reduce interior speech interference levels (S.I.L.) by an average of about seven decibels.

Test results, which were based on measurements made by Douglas Aircraft Company, showed passenger compartment S.I.L. ranges are reduced as much as 11 db.

Speech interference level, considered the most important of interior noise measurements, is the average of the readings in the three octave frequency bands between 600 and 4,800 cps. Conversation can be understood if the S.I.L. is equal to the level of speech. However, for 100 percent intelligible speech, S.I.L. should be 12 db below the level of speech.

In the Caravelle tests, 80 percent of the passenger compartment measurements fell below the normal voice levels of passengers sitting one foot apart. At raised voice levels not one voice level condition fell above S.I.L. measured, while some of the noise levels are low enough for 100 percent intelligible speech.

External noise measurements on the Caravelle show that it is by far the quietest jetliner flying. For example, at normal gross weights with full take-off power, noise levels on the ground under the flight path 8,500 feet from start of take-off roll are less than 112 PNdbs.

G.E.'s aft-fan-equipped Caravelle is now in its fifth month of intensive flight test at Edwards AFB, Calif. Performance and test results to date have proven highly favorable.

See the CJ-805-23 at the Paris Air Show

T64/Grumman Gulfstream Program Announced

BETHPAGE, N.Y.—An active development program for installation of General Electric T64 turbo-prop engines on the Grumman Gulfstream has been announced by Grumman Aircraft Engineering Corporation.

The Gulfstream, now in service in the United States and throughout the world, is the first twin-turboprop aircraft in its size category designed specifically for corporate use.

In a similar development program, engine installation work on the T64-powered deHavilland Caribou is nearing completion. A nine-month flight test program is scheduled for early this summer.

Other installation studies of T64 turboshaft/turboprop configurations are underway by a number of airframe companies proposing the T64 for VTOL aircraft.

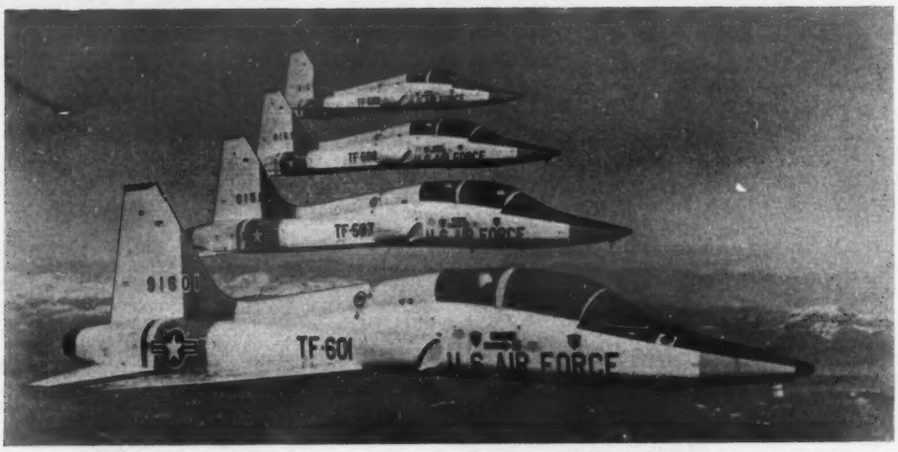
General Electric's 2,850 shp T64 engine offers a very attractive power-to-weight ratio. It has a low specific fuel consumption, which is maintained from military to approximately 50 percent of power.

A designed-in ability to operate continuously at attitudes from 100 degrees above the horizontal to 45 degrees below makes it highly adaptable to VTOL/STOL applications.

→

General Electric's T64 turboshaft engine will be among those on display at the Paris show

Flight Propulsion NEWS



Sleek, supersonic T-38s will school USAF pilots in the rigours of space-age flight

T-38 Supersonic Trainer Enters Service; Will School USAF Pilots by Year's End

RANDOLPH AFB, Tex.—A new era in supersonic flight training began in mid-March here with delivery of the Air Force's first operational T-38 trainers.

For the two-place Northrop jet, this was the last step prior to entering full-fledged service as a " supersonic classroom " for space age pilots. The T-38 will provide new dimensions in safety and versatility to pilots training in the art of supersonic flight.

According to Air Training Command schedules, the aircraft will be used for instructor familiarization and checkout here until early fall. Then it will transfer to Webb AFB, Texas, and fully operational training status.

The T-38 " Talon "—powered by twin General Electric J85-5 turbojets—is the world's first supersonic aircraft designed expressly for training purposes. It combines performance capabilities of jet fighters twice its size with the highest safety assurance of any aircraft in its performance class.

The new trainer has Mach 1.2 speed capabilities, and a maximum rate-of-climb of 30,000 feet per minute. A single-place counterpart of the T-38, Northrop's N-156F " Freedom Fighter, " has somewhat greater performance capabilities.

See the J85 engine at the Paris Air Show

Vertol Copter Selected as US Marine Transport

WASHINGTON, D.C.—A military version of the Boeing-Vertol 107 turbine-powered helicopter has been selected as assault-transport for the U.S. Marine Corps.

Like the 107-II, the military Vertol craft will be powered by two General Electric T58-8 gas turbine engines.

The Vertol 107 prototype design originated as a 1700 hp turbocopter. Two of these ships have been uprated to 2300 hp and are now undergoing FAA certification tests. The 25-passenger commercial version—the 107-II—will enter service this year with New York Airways.

Primary innovation in the Marine Corps version will be power-operated folding rotors, making the transport adaptable to the limited elevator and hangar dimensions of Naval assault ships. It will be fitted with 26 seats, and will handle pay loads of over 5,000 pounds.

The G-E T58 engines, which will provide the turbocopter with 130 mph cruising speed and 145 mph top speed, have already proven their reliability on commercial and military helicopters in over 45,000 hours of operation.

G-E T58 engines also power the U.S. Navy's Sikorsky HSS-2 helicopter and its commercial version—the S-61, Kaman's HU2K, and the FAA-certificated Sikorsky S-62.

See the T58 engine at the Paris Air Show

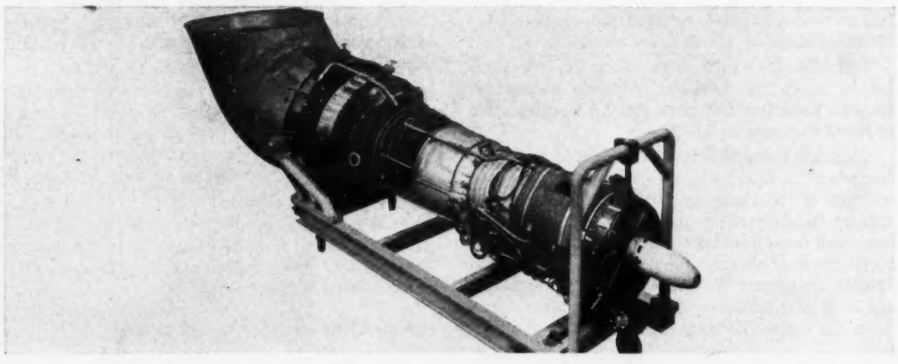
2905 MPH Hit by X-15; Top manned speed mark

EDWARDS AFB, Calif.—The X-15 rocket plane streaked to a new manned-flight speed mark of 2,905 mph on March 7 here.

The experimental aircraft, whose mission will soon carry it to the fringes of space at speeds up to 4000 mph, made its run at 75,000 feet.

Power for the X-15's electrical and hydraulic systems was supplied by two General Electric auxiliary power units, unique turbodrives that operate independently of the aircraft's rocket engine. The hydrogen peroxide powered APU's assure aircraft control and pilot safety.

See General Electric's constant speed drives at the Paris Air Show



Model 240 Marine Turboshaft on Test

CINCINNATI, Ohio—General Electric's Model 240 turboshaft engine is now undergoing qualification test prior to application on the U.S. Maritime Administration's 80-ton, 60-knot hydrofoil craft scheduled for sea trials this summer. The engine is part of a marine power package offered by G.E. that includes powerplant, transmission, and docking engine.

A modified turboshaft version of General Electric's proven CJ-805 commercial turbojet, the basic Model 240 engine weighs 6,600 pounds, only one-tenth as much as similarly rated reciprocating engines and steam propulsion systems. Its compact size makes it suitable for displacement ship propulsion, and use as a mobile electric power unit.

Besides size and weight advantages, the Model 240 is expected to offer sizeable benefits in maintenance simplicity. The G-E powerplant consists of a CJ-805 turbojet engine coupled aerodynamically to a newly designed power turbine that converts jet thrust to turboshaft horsepower.

High speed hydrofoil vessels are expected to play an important role in the future of marine transportation. Planned future versions will carry hundreds of passengers at 80-knot speeds.

See the Model 240 Engine at the Par s Air Show

End of the 257th test mission: the F-104/J79 hits 500 hours without major overhaul

F-104 Achieves 500 Flight Hours Without Major Engine Overhaul

TINKER AFB, Okla.—The Lockheed F-104/J79 weapon system has shown that it can achieve 500 flight hours without a major engine overhaul.

Capability of the "Starfighter's" J79-GE-7 engine to reach the 500-hour mark was proven by a USAF accelerated service test mission terminated during March.

The program was conducted over a six month period, and involved 257 typical Tactical Air Command missions. It was jointly managed by the USAF's Oklahoma City Air Material Area Maintenance Division, and the General Electric Company.

In the U.S. Air Force and the Air National Guard, F-104/J79 effectiveness has been measured by daily use. Better than 98 per cent of over 35,000 flights have been reported trouble-free.

The J79 engine of the Mach 2 fighter produces nearly 16,000 pounds of thrust, yet weighs less than 3,600 pounds. It has powered the F-104 to eight world time-to-climb records, and the world altitude record of 103,395 feet.

See the J79 engine at the Paris Air Show

VTOL Flight by 1963 Slated for G-E Lift Fan

CINCINNATI, Ohio—First flight test of a lift-fan powered VTOL aircraft is planned for 1963 by G.E.'s Flight Propulsion Laboratory Department here.

The G-E timetable is based on a proposed flight research test series demonstrating capabilities of the company's J85-powered lift-fan for aircraft of the future. Estimates are that a lift-fan powered jet aircraft will be airborne 21 months after start of the program.

Under the proposed G-E plans, an experimental aircraft will be equipped with two wing-mounted lift fans powered by J85 engines installed in the fuselage. Engine thrust will power the fans during takeoff and landing, and will be converted to jet thrust for horizontal flight.

An important VTOL safety factor will be incorporated by cross-ducting each engine's thrust so that equal amounts are delivered to each fan. With this arrangement, 61 percent of the aircraft's design lift can be retained in the event of an engine failure.

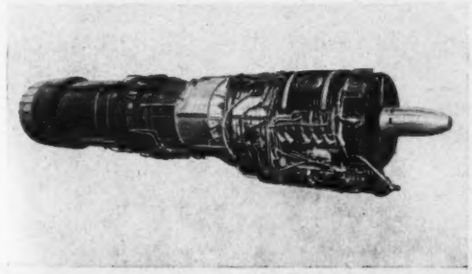
General Electric's proposed flight research program will culminate four years of basic lift-fan development and research. A J85-powered lift-fan engine has already completed over 100 hours of successful test-bed and wind tunnel operation.

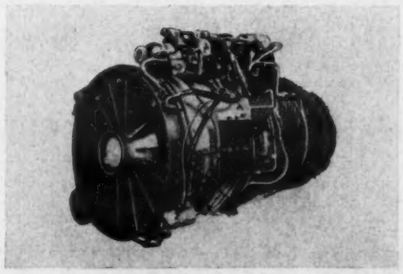
See the General Electric lift-fan display at the Paris Air Show

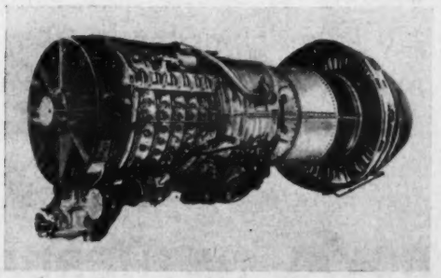
The lift fan look: one of several airframes considered by G.E. for VTOL testing

See These Engines—and—Others at the Paris Air Show...

On display at General Electric's Paris Air Show stand will be: *Left*, the J79 16,000-lb-thrust-class powerplant that has powered the Air Force's F-104 and B-58, and the Navy's A3J and F4H to 18 world flight records; *Center*, the J85, recently modified to provide an unequalled 10-to-1 power ratio; and *Right*, the CJ-805-23 aft-fan turbojet, currently powering the Convair 990 and Caravelle VII. Others on display will include the CJ610, and CF700 commercial powerplants, and the T58 and T64 turboshaft engines.







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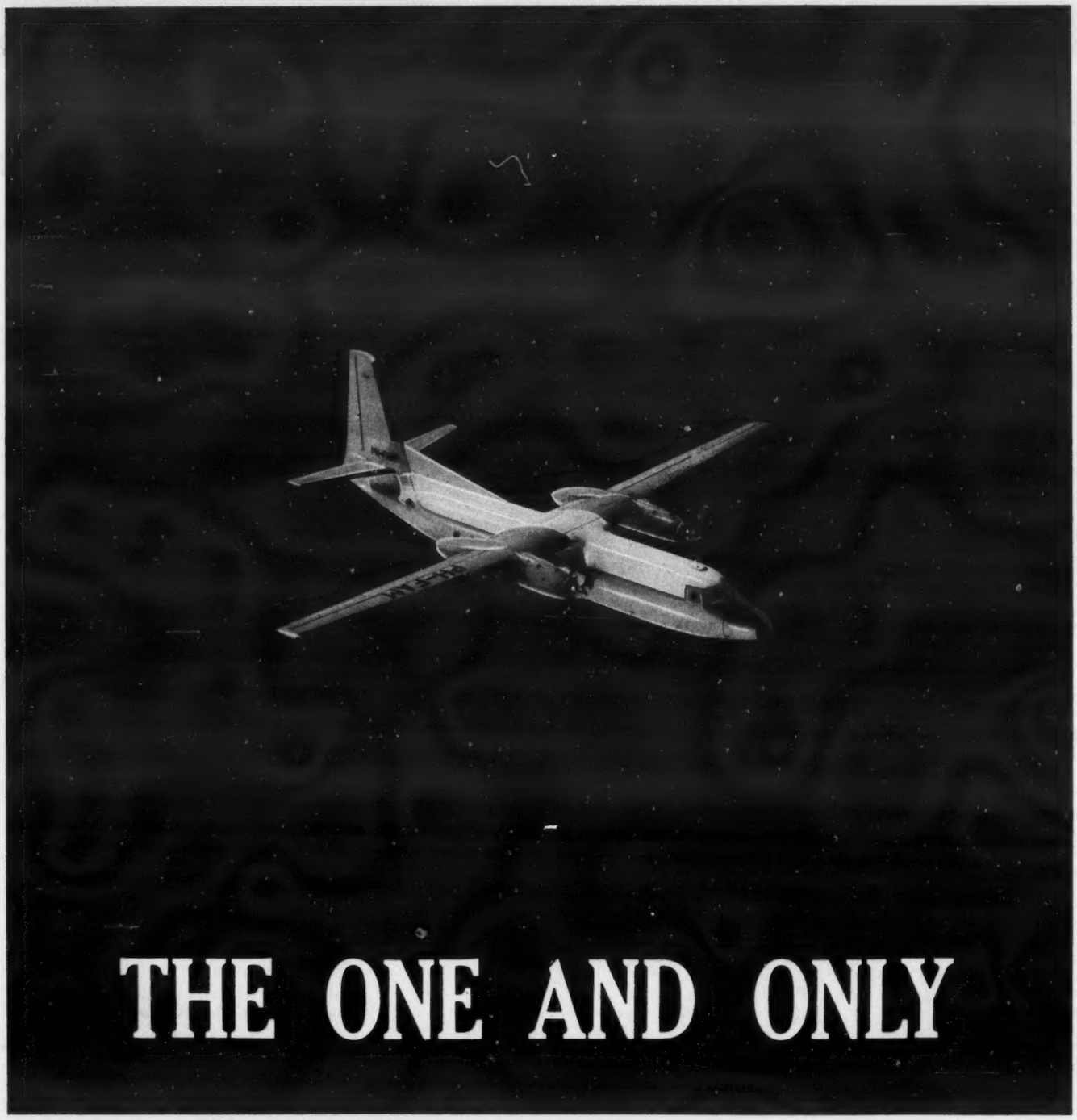

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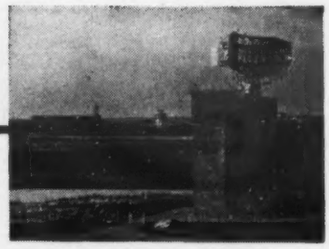
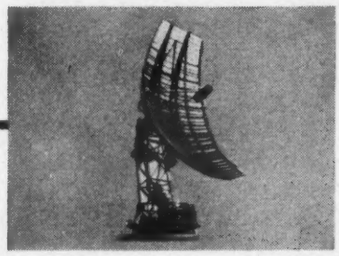


AUTOMATIC TRACKING RADAR



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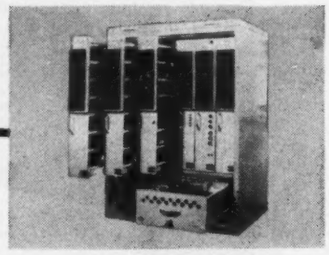

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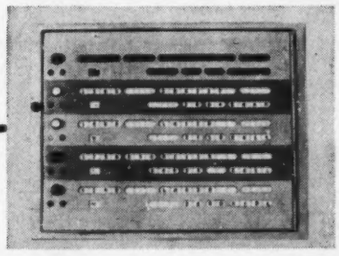
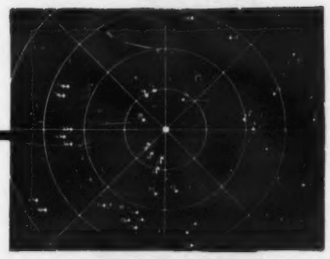
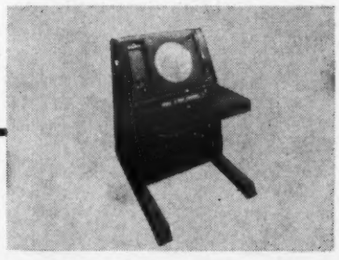


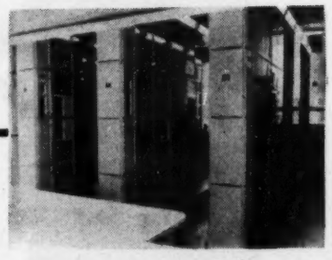
AUTOMATIC LARGE SCALE GENERAL ASSEMENT DISPLAYS



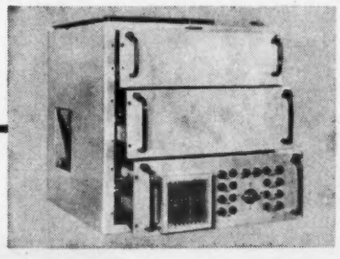
TRANSISTORIZED RADAR AND SYNTHETIC DISPLAYS



SEMI AND FULLY AUTOMATIC TELEGRAPH EXCHANGES



GROUND-GROUND AND GROUND-AIR TRANSMITTIMG AND RECEIVING EQUIPMENT



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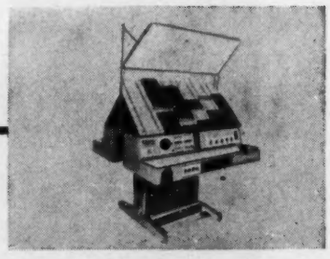

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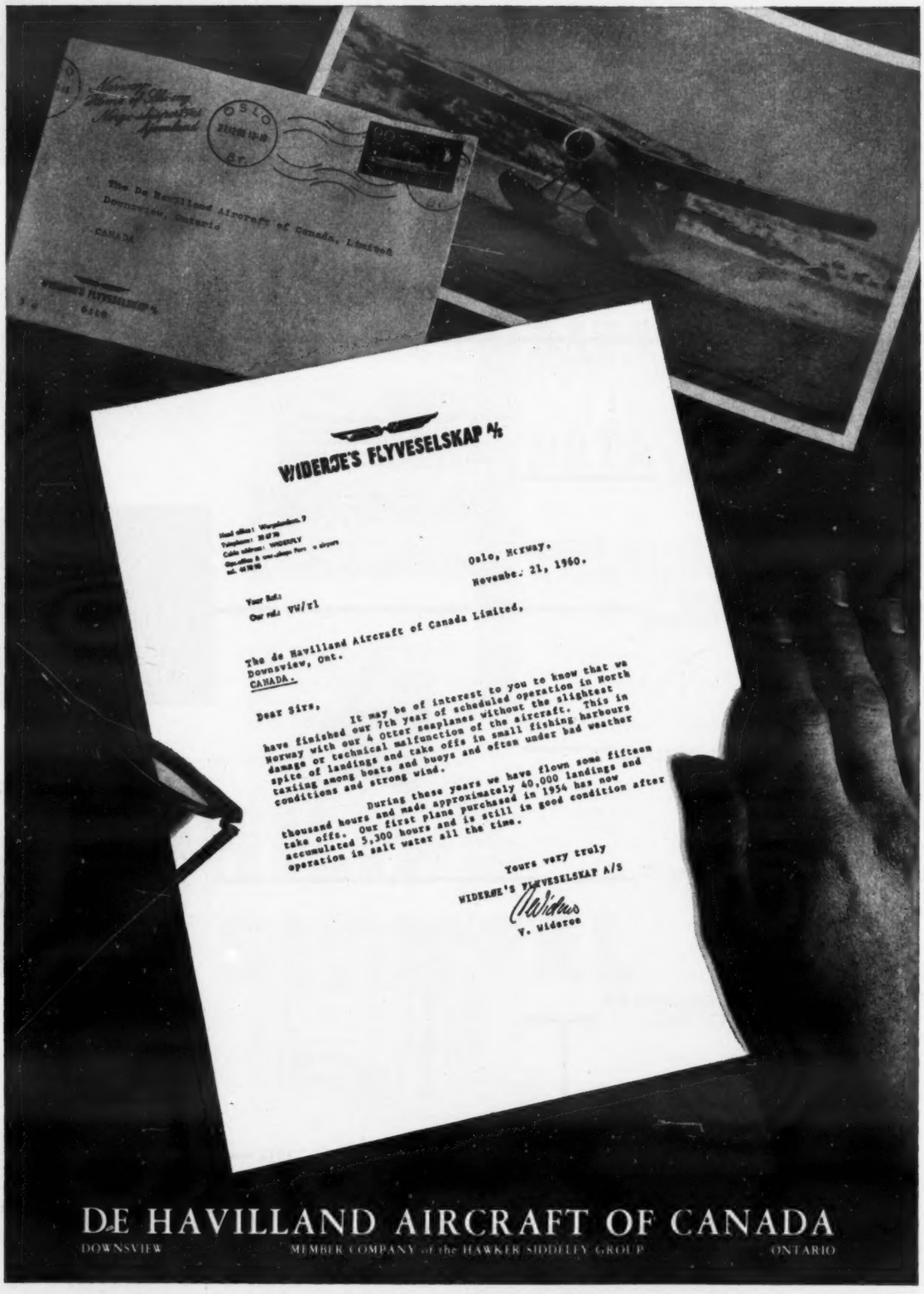
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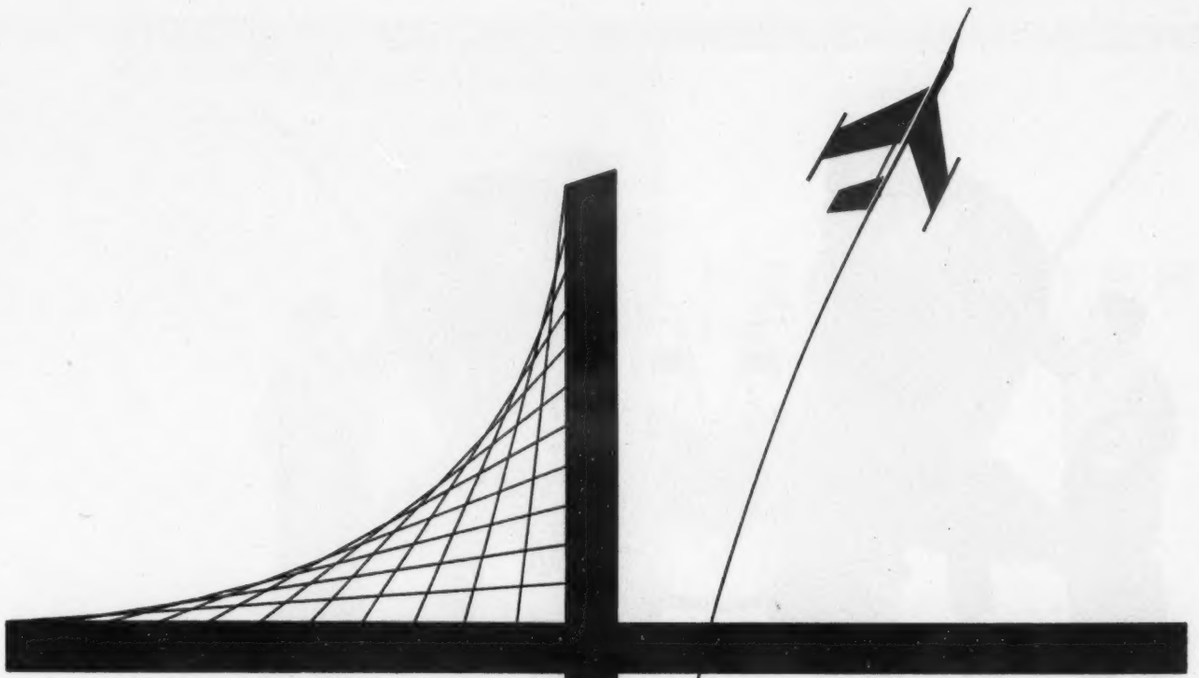
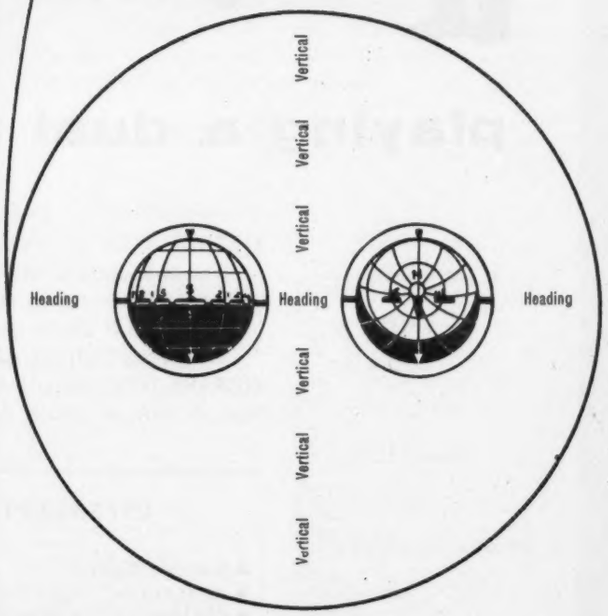


Flight tests
Sensors
Receivers
Recorders
Telemetry equipment

Aircraft instruments
Gyro compass
Radio compass
Oxygen regulator
Rate gyro
Helicopter automatic pilot



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● BLIND OR VISUAL ATTACK	● BLIND OR VISUAL ATTACK

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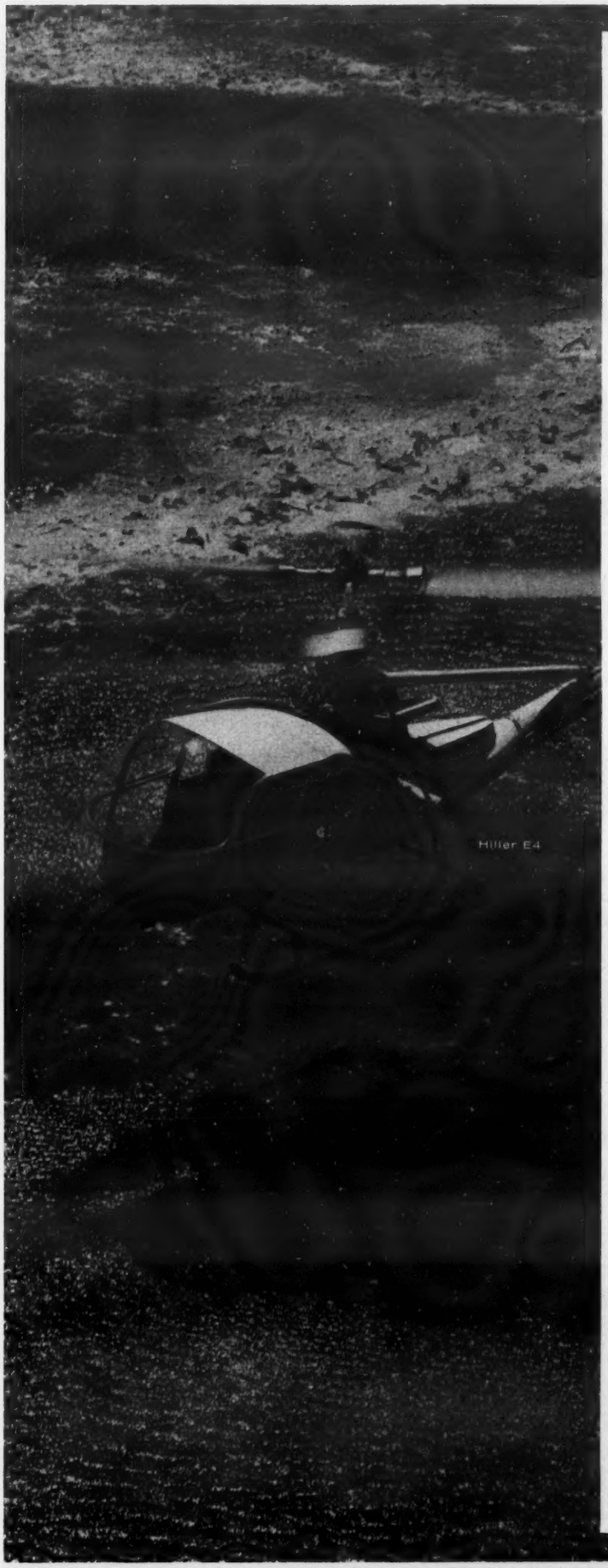

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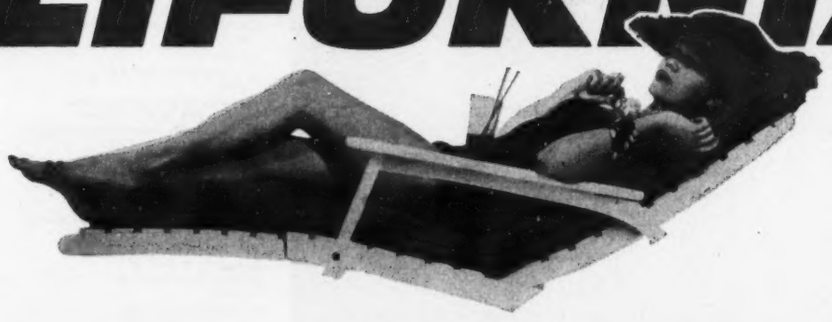

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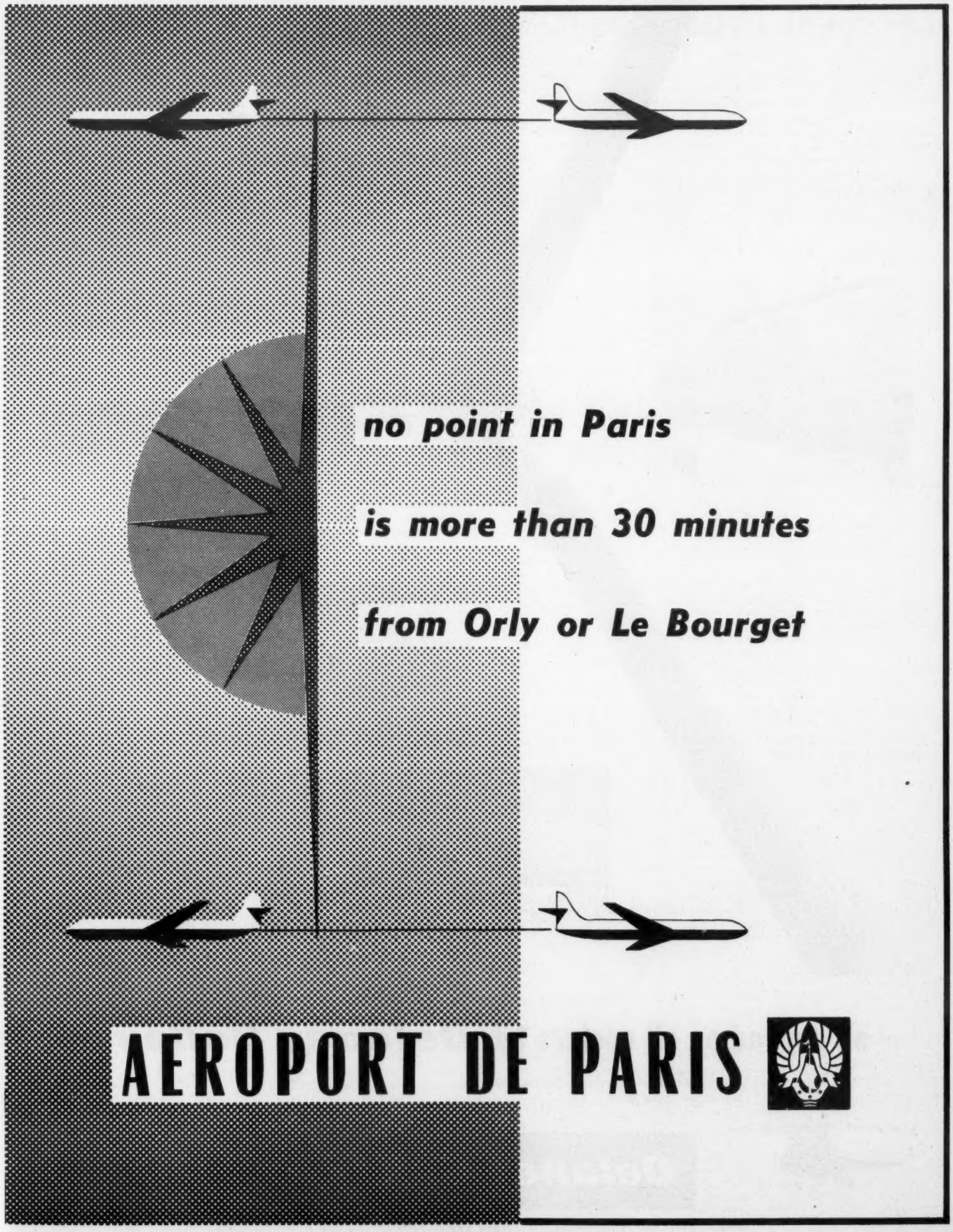
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ABC OF THE FRENCH EQUIPMENT INDUSTRY

ABG (Paris & Courbevoie):
Ignition equipment for piston and jet engines; high-energy igniters; *Edison* fire indicators; fire and smoke detectors; engine and airframe accessories.

ADR, Les Applications du Roulement (Paris):
Ball and roller bearings for controls; gyros; generators; bearings for aircraft instruments etc.

Aérazur, Société (Issy-les-Moulineaux):
Inflatable life-jackets, parachutes and rescue equipment of all kinds; anti-G suits; pneumatic dinghies to accommodate up to 20 occupants; pneumatic equipment; plastic aircraft arrester nets (in collaboration with Rolba).

Air-Equipement S.A. (Asnières):
Aircraft instruments, including indicators and sensors; rate of climb indicators; gyro compasses; quantity meters; autopilots and automatic heading indicators. Pressure and vacuum equipment; servo controls; hydraulic pumps and undercarriage components. Radio direction finders; radio and radar equipment. Starters; generators; alternators; regulators and ventilators. Regulation and feed systems for piston engines and gas turbines. Equipment for helicopters and guided missiles.

AMA, Etablissements (Levallois-Perret):
Engine monitoring equipment; lubricant and fuel filters.

AMP de France (Le Pré-Saint-Gervais):
Represents the American firm of AMP Inc. and sells its products (terminals and connectors).

Andyar, Société (Neuilly-sur-Seine):
Light silver-zinc accumulators for high-performance turbojets.

Aster, Société des Compteurs et Moteurs (Ivry/Seine):
Electric motors and meters; automatic systems for the remote control of Rolba arrester nets.

Auxilec, Auxiliaires Electromécaniques de Précision (Colombes):
Electrical equipment; electric motors; inverters for guided missiles; gas turbine starters. Voltage regulators; development and production of electronic aircraft equipment; transformer/rectifiers; transformer motors and electric blowers.

Aviac, Etablissements (Courbevoie):
Mechanical and electrical remote actuator systems; quick-release valves.

Aviradio (Issy-les-Moulineaux):
Transmitters and receivers, including ER-144 with 360 or 720 channels; meets French air traffic control specifications for IFR equipment and the American TSO-FAA regulations. Also miniaturized equipment with a total weight of 8.36 lb. Further versions: ER-144C (120 channels); ER-144D (720 channels); ER-144.1 and ER-144.2 aero club versions.

Beaudouin, Etablissements (Châtillon-sous-Bagneux):
Industrial measuring equipment; photographic recording equipment and copying machines; auxiliary flight test equipment; acceleration and vibration detectors; receivers; pressure meters.

Boet & Cie. (Ascq).
Airfield noise suppressors for gas turbines; noise suppressors for jet engine static tests; acoustic insulation of engine test stands.

Breguet, S.A. Ateliers d'Aviation Louis (Paris):
General engineering; hubs for variable pitch propellers etc.

Breguet-Garrett S.A. (Paris):
Air conditioning and cooling systems.

Bronzavia S.A. (Courbevoie):
Engine accessories; electric pumps; voltage transformers; aircraft equipment (intercom equipment, reflector and gyro sights); gun cameras; bomb aiming devices; radio equipment; VHF transmitters and receivers.

Cégédur, Compagnie Générale du Duralumin et du Cuivre (Paris):
Semi-finished parts from non-ferrous metals and high-tensile light alloys; plates and sections; special alloys for forged parts.

CEMAT, Compagnie Européenne des Matériels Thermiques (Paris):
Heat exchangers; lubricant coolers; heat exchangers for electronic circuits; air coolers for engine superchargers and aircraft cabin air conditioning systems.

CGP, Compagnie Générale des Plastiques (Croissy-sur-Seine):
Electric wires and cables; NRAN 5 and NRAN 8 (Bendix-Bezu); coaxial cables; special missile cables. Ceramically insulated wires for continuous operation up to maximum temperature of 250°C; AV 11, AV 12 and AV 15 thermostats (regulation of heated glass plates); acoustic warning systems.

Champion, Société de Construction de Machines Electriques et Pneumatiques (Paris):
Portable pneumatic machine tools and accessories.

Chausson S.A. (Asnières):
Thermal equipment; lubricant and water coolers; heat exchangers; cabin air conditioning.

CIMA, Cie. Industrielle de Matériel d'Aviation (Courbevoie):
Flexible hoses; protective coverings for fuel tanks.

Le Collier Industriel (Bry-sur-Marne):
Flexinox clamps and stainless steel screws (to U.S. standards).

Combin (Courbevoie):
Passenger seats and cabin equipment in general.

COTELEC, Société Fran aise d'Etudes et de Constructions Electroniques Derveaux (Boulogne):
Remote control and telemetry equipment for aircraft and guided missiles; radar telemetry equipment; fire control systems; homing systems; recording equipment; antennas; analogue computers; aircraft equipment in general, aiming devices.

CRMA, Société de Construction et de Réparation de Matériel Aéronautique (Issy-les-Moulineaux):
Production of spare parts for Pratt & Whitney, Wright, Lycoming, Régnier 4L and Renault 4P piston engines. Maintenance and overhaul of these engines.

Crouzet Aviation (Valence):
Computers; Machmeters; parachute release devices.

CSF/SFR, Compagnie Générale de Télégraphie Sans Fil (Paris):
Large solar converters for use in tropical regions. Equipment for the remote transmission of radar signals; fully transistorized radio navigation equipment (radio altimeters and direction finders); electromechanical components; electronic tubes etc. Radars for the control areas of Paris (Orly), Marseilles, Bordeaux, Lyons; aircraft radars and fire control systems for military aircraft (including the *Cyrano*). Also airborne storm and obstacle warning radars; radio altimeters; electronic computers.

Dunlop, S.A. des Pneumatiques (Paris):
Tyres; wheel brakes; anti-icing equipment; seat fittings.

EAA, Equipement d'Avions et d'Aérodromes (Paris):
Design and planning offices for special airport, also aircraft, equipment.

ECE, L'Equipement et la Construction Electrique (Paris):
Generators; contactors; safety switches; servo and autopilot systems.

EFA, Société d'Etudes et Fabrications Aéronautiques (Clichy):
Auxiliary and protective equipment, particularly for ejection seat and parachute equipment; parachutes for crew and cargo dropping; belts for crew and passengers; chronobarometric actuators for automatic parachute opening; complete pressure suits.

ESPA, Société d'Equipements Spéciaux pour l'Aviation (Montreuil):
Flexible hosing and hose unions; light construction piping systems; air conditioning systems.

Faure-Herman, Etablissements (Boulogne):
Fuel metering equipment and flow meters for turbines and piston engines.

Fenwick S.A. (Paris):
Tools and machine tools, as well as mobile lift and fork lift equipment, UHF equipment for laboratory use.

Fermeture-Eclair/Division Marston (Rouen):
" Flexelite " pliable fuel tanks; laminated materials for radomes; antenna housings; light metal alloys.

Filotex, Etablissements (Draveil):
Cable wires (power and radio); coaxial cables, protective casings and copper screenings; particularly special cables and signal cables.

Geffroy & Cie., Etablissements Férisol (Trappes):
All types of electronic measuring equipment for laboratory use; VSWR measuring equipment type TO/201A, reflectometer-wattmeter type NTO/101 etc.

Gerzat, Société Métallurgique de (Paris):
Light alloy bottles for compressed and liquid gases, including 11 gallon compressed air bottles (5,000 p.s.i.) for starting jet engines; oxygen bottles (contents 16 cu. in. to 11 gallons at pressure up to 4,160 p.s.i.); respiration equipment. Carbon dioxide bottles for fire extinguishers, liferaft dinghies, life jackets.

Guiot S.A., Etablissements A. (Paris):
All types of booster pumps, particularly for de-icing; feed pumps.

H.B., Etablissements (Issy-les-Moulineaux):
Fireproof, flexible high and low pressure lines for fuel, lubricants and hydraulic liquids. Components of special rubber and silicones.

Hispano-Suiza S.A. (Bois-Colombes, Paris):
Jet engines; undercarriages (SE.210, *Caravelle*, Breguet 1050 etc.); lathes; atomic energy systems; diesel engines. Also hydraulic equipment such as pumps and generators, reservoirs; servo equipment. Also pneumatic equipment (pressure cylinders, valves, shock absorbers, air compressor systems for presses, graduating machines, pneumatic tool drives).

Intertechnique SRL (Boulogne-Billancourt):
Electronic fuel gauges; " Wig-O-Flex " semi-rigid pipe unions; high-altitude equipment for pilots, including oxygen regulators; electronic equipment; temperature gauges for compressors, turbines and thrust nozzles.

Jacottet S.A. des Etablissements (Versailles):
Self-locking flight servo-control equipment; controlled hydraulic actuating cylinders; remote controls, particularly power-amplified controls; mechanical remote-actuation devices.

Jaeger S.A., Etablissements (Levallois-Perret):
Mechanical and electrical aircraft instruments; accelerometers; testing and control rigs.

La Jonchère, Manufacture Métallurgique de (Paris):
Fire resistant high pressure stainless steel hosing for use in fuel and lubrication systems etc.

Kléber-Colombes Aviation (Paris):
Laminated tyres for jet aircraft, with treads reinforced by layers of nylon threads embedded in the rubber. Also: " Tubeless R-Metic " and " Cross-Country " tyres (the latter particularly suitable for operation from makeshift airfields); pneumatic de-icing units for the leading edges of wing and tail assembly and for propellers; " Klégécell " and " Klémocell " ultra-light construction materials.

Labinal, Précision Mécanique (Saint-Ouen):
Development and construction of remote control systems for drones; " Labamatic " controlled frequency generators; servo systems; electric and electronic equipment; starter units.

Latécoère, Société Industrielle d'Aviation (Paris):
Missiles and missile accessories.

Le Bozec et Gautier (Courbevoie):
All types of engine accessories; filters; cooler and fuel tank parts; control equipment for fuel and lubricant systems.

LMT, Le Matériel Téléphonique (Boulogne-Billancourt):
Long-range reporting techniques and electronics, including all types of radio equipment, electronic instrument flight trainers, particularly LMT type 141; remote control systems; TACAN equipment under licences from ITT.

Magnésium Industriel S.A., Le (Le Blanc-Mesnil):
All types of magnesium parts and components.

Magnésium, Société Générale du (Paris):
Ultra-light magnesium alloys and semi-finished parts.

Matra, Société Générale de Mécanique-Aviation-Traction (Boulogne-Billancourt):
Design and construction of special aircraft and missiles; rocket launching ramps; aircraft armament; autopilot equipment etc.; special rockets and other aircraft armament.

Messier S.A. (Montrouge):
Design and construction of undercarriages; hydraulic and electro-hydraulic actuation systems for use in aircraft; wheels and wheel brakes and " Ministop " brake pressure regulators; high pressure pumps; test-rigs; electronics; *Jockey* all purpose undercarriage for use on makeshift airfields.

Métallurgique d'Imphy, Société (Paris):
Steel and light metal castings, especially for use in turbo-engine construction.

Martin, Moulet & Cie. (Oullins):
Hydraulic equipment, industrial fittings; motor pumps.

OMERA-SEGID, Société d'Optique, de Mécanique, d'Electricité et de Radio (Argenteuil):
Electronic, optical and precision engineering products; VHF and UHF equipment; radar; radio beacons; optical reconnaissance equipment (SEPHOT licences). Also aircraft transmitter/receivers under licence from SARAM (SARAM TR-AP-6 VHF and SARAM TR-AP-11A, -21A and -22A UHF); radio beacons under licence from AGA; radar equipment under licence from Decca; gun cameras types 20, 100 and 110; photographic equipment types 11, 30 and 31.

Ottawa, Etablissements (Paris):
Coaxial cables; printed circuits; antennas.

Péchiney, Compagnie de Produits Chimiques et Electrométallurgiques (Paris):
Paints, lacquers, adhesives and all types of chemicals.

Potez, Etablissements Henry (Paris):
Portable generators and emergency power units.

Précilec S.A. (Paris):
Small electromotors; powerplants for servo controls; electro-mechanical equipment of all types; licences from the Norden Division of United Aircraft Corp.

Radio-Air S.A., Applications Industrielles Radio-Electriques (Asnières):
Aircraft transmitters-receivers, radio compasses; magnetic tape units; intercommunications systems.

Ragonot, Etablissements E. (Malakoff/Seine):
Small and medium output electromotors; generators; transformers.

Ratier-Figeac S.A. (Paris):
Propellers, particularly adjustable propellers for turbine engines, as used in the Beech PD.18, the Breguet 941, 942 and 945, the Dassault *Communauté*, the Potez 840, the *Super Broussard* etc. Precision engineering for helicopters (rotor heads, transmission systems).

Rellumix, Etablissements Muller (La Garenne-Colombes):
Fixed and mobile pump systems for aircraft and missile supply; fuel and lubricant filters, microfilters; high-speed refuelling systems.

Rolba, Société des Ateliers (Grenoble):
Production of braking systems, as required for use in conjunction with safety barriers (cf. Aérazur and Aster).

Rubanox SRL (Neuilly):
Sheet metal working, in particular production of exhaust stacks and thrust nozzles; Nimonic and Hastelloy metal working.

SAFT, Société des Accumulateurs Fixes et de Traction (Romainville):
Everlasting aircraft batteries; special-purpose accumulators; Leclanché batteries.

SAGEM, Société d'Applications Générales d'Electricité et de Mécanique (Paris):
Navigational aids; gyro and synchro equipment etc. for aircraft, including licence construction of the GPL analogue and digital computers.

SAMM, Société d'Applications des Machines Motrices (Issy-les-Moulineaux):
Equipment and accessories for high-pressure hydraulic systems; hydraulic pumps; servo controls; control column hand grips.

SAPELEM, Société d'Application de Procédés Electriques et Mécaniques (Paris):
Cleaning vehicles for runways and parking places (Bertin & Cie process), particularly types T.M. 750 and T.P. 500; pneumatic equipment.

SARAM, Société d'Applications Radioélectriques à l'Aéronautique et à la Marine (Asnières):
Aircraft transmitters and receivers, types 5-41, 5-42 and 5-52 (VHF) and types TR-AP-11A, TR-AP-21A and 7-60.

SARMA, S. A. de Recherches de Mécanique Appliquée (St. Vallier-sur-Rhône):
Aircraft control systems for the *Mirage III*, the *Mirage IV*, the *Etendard IVM*, the Breguet 941 and 1150, the Potez 840 etc. Agencies of and licences from King Aircraft Corp. and Pacific Scientific Co.

SATAM, S.A. pour Tous Appareillages Mécaniques (La Courneuve):
Equipment for tankers; aircraft equipment of all types, including pressure fuelling systems; cooling systems for pre-cooling of passenger cabins.

Sciaky S.A. (Vitry):
Resistance welding machines; electronic control systems.

SEA, Société d'Electronique et d'Automatisme (Courbevoie):
High-powered servo controls; electronic computers and simulators.

SECAN, Société d'Etudes et de Constructions Aéro-Navales (Gennevilliers):
Metal-working processes; welding of stainless steels, titanium etc. Production of thrust nozzles for turbojets; cooling jackets; jettisonable auxiliary tanks.

SECAPEM (Paris):
Javelot towed targets, equipped with the MAECEV-SFENA detection system which tracks the projectile, measures the deviation from target and reports back to the surface station.

SEMCA, Ateliers (Toulouse-Aucamville):
Self-contained turbine jet engine starters and ground starter units; air conditioning systems; cabin pressure regulators; check and distributor valves; air supply regulators.

SEPR, Société d'Etude de la Propulsion par Réaction (Villejuif):
Rocket engines of all types using liquid and solid propellants; measuring instruments; accessories. Also test systems (test rigs for thrust measurement). Heating and cooling systems; experimental work in the field of nuclear energy.

SFENA, Société Française d'Equipements pour la Navigation Aérienne (Neuilly):
Equipment and electronics, especially flight regulators, gyro-controlled navigation equipment, servo controls. Also systems for position-finding and guiding aircraft and missiles; remote controls; long-range measurement systems; miniature precision motors; new artificial horizon type 707 for large civil jets.

SFERMA, Société Française d'Entretien et de Réparation de Matériel Aéronautique (Suresnes):
General overhaul and repair of flight equipment; integral fuel tank lining and seals; inspection of small gas turbines (Turboméca); production of aircraft spares and components; manufacture of auxiliary equipment.

SFIM, Société de Fabrication d'Instruments de Mesure (Massy):
Complete choice of photographic recording apparatus for speed, pressure, altitude, course, distance, stress, acceleration etc.; A.27 self-contained recording equipment for parachutists; light, air-transportable recording equipment type A.20 for six parameters and type A.26 for 16 parameters; recording equipment for laboratories, type AO.10, manufactured under licence from ONERA, which records more than 25 parameters simultaneously. Also aircraft instrumentation, gyro-compasses, radio compasses, regulators for oxygen equipment, stall warning devices, air attitude indicators with two gyros. Radio telemetry for aircraft and missiles. I.16 miniature gyro measuring equipment.

SFOM, Société Française d'Optique et de Mécanique (Rueil-Malmaison):
Aircraft cameras (including type 34 for 7 in. × 10 in. pictures); telephoto lenses, optical aiming devices (including large scale production of types 83 and 83A) and photographic accessories.

SINTRA, Société Industrielle des Nouvelles Techniques Radio-Electriques (Asnières):
Practice and auxiliary equipment for radar controllers; radar testing equipment; analogue and digital computers.

SIPA, Société Industrielle pour l'Aéronautique (Neuilly):
Cabin equipment, especially passenger seats.

Siren S.A., Etudes et Productions Aéronautiques (Versailles):
Aircraft equipment, especially installations for simplifying loading and unloading of freighters (such as roller track); cargo stowing equipment for aircraft; cargo winches for helicopters; passenger seats; ground transport devices for aircraft.

SNFA (Ivry):
High precision ballbearings and roller bearings.

SOCAPEX (Suresnes, Paris):
Pygmy PT miniature plugs (under licence from Bendix) for 10 socket sizes (up to 61 pins); also microphones; earphones; radio parts.

SOCRAT (Paris):
UHF transmitters and receivers; VHF airborne equipment; UHF/VHF remote control and maintenance/test equipment for ground and workshop use.

Sofrance S.A. (Paris):
Petrol and kerosene filters, in particular type K3 for retention of all solid constituents larger than 1/10 micron; water-separators.

SOM, Société d'Optique et de Mécanique de Haute Précision (Paris): Optical equipment and accessories; aerial cameras.

Souriau & Cie., S.A. (Billancourt):
Electrical equipment; connectors complying with French and U.S. standard specifications; plugs for circuits; coaxial plugs; weatherproof connectors.

Superflexit S.A. (Courbevoie):
Flexible hosing, flexible fuel tanks.

Técalémit S.A. (Paris):
High precision flexible hosing for hydraulic systems; cabin conditioning systems; fuel and lubricant distributors.

Téléflex S.A. (Ivry-sur-Seine):
Mechanically power-boosted aircraft controls.

Télec (Paris):
Great variety of aircraft equipment, such as noise meters; variable resistances; ultra-violet lights; flashers for recognition lights; electric temperature and elongation meters; stress meters; oscillograph-recorder units.

Thomson-Houston, Compagnie Française (Paris):
Long-range reporting systems and electronics; fire control radar equipment; radio communications equipment; radar systems for air traffic control, airspace surveillance and precision approach. TH.D.1013 mobile automatic tracking radar; training simulators for GCA operators; TH.C. 9600 ground-to-air system for all ground-to-air radio communications (1,750 to 3,500 channels)—this system is being produced for, amongst others, the French forces; the *Lynx* experimental detection system for mines dropped by aircraft, also suitable for marine and port traffic surveillance; and the TH. 2011 and TH. 2101 very high power klystron amplifiers (20/30 MW). Series of special tubes for VHF, UHF and SHF equipment. UHF radar tubes and tubes for image analysis and light amplification.

Triplex, Société Industrielle (Longjumeau):
Therglas frostproof glass for passenger cabin windows and cockpit use; armoured glass.

TRT, Télécommunications Radioélectriques et Téléphoniques (Paris): HF, VHF and UHF radio equipment; directional radio link equipment for telephone and TV; long-range data transmission and measurement equipment; special electronic equipment for missiles and altitude sondes.

Vibrachoc, Société (Paris):
All types of shock and vibration damping suspensions (under licences from Robinson Aviation).

Vinot-Aviation (Paris):
Electric turn-and-bank indicators; all types of airborne instrumentation; general engineering and machine tool production.

Zénith S.A., Société du Carburateur (Levallois-Perret):
Fuel tanking and feeding etc., equipment for all aircraft and airport fuel delivery systems. Licences from Bendix, Hobson, Flight Refuelling, Plessey, and Saunders Valve.

THE TREND IS TOWARDS AIR PARTNERSHIP

Atlas Copco's contribution to the jet-age — an Air Partner starting a jet airliner at London Airport

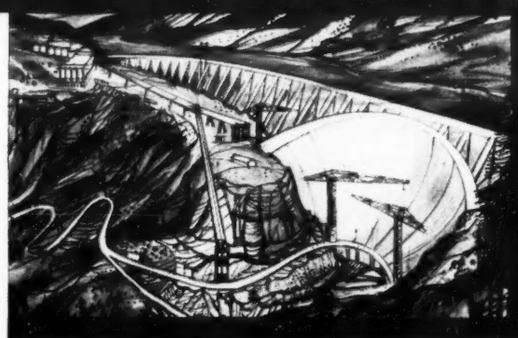
Compressed air is power. Little more than one minute is needed for the Atlas Copco "Air Partner" to start the four-engine jet giants of today. Many of the world's principal airlines now use this mobile screw compressor unit – and at Idlewild, London, Orly, Dusseldorf, Hong Kong and other major airports the Air Partner is regarded as an essential part of the ground service facilities.

Wherever you go you will find Atlas Copco equipment at work; portable compressors for a new Middle East pipeline, sprayguns at Jaguar's Coventry works, loaders in the German coalmines or rock drills for Ghana's new Tema Harbour project. The company's air-tools are used to build Sud-Aviation's Caravelle. Philips, Vauxhall and I.C.I. have chosen Atlas Copco compressors for applications where continuous air supplies are vital.

With companies or agents in more than 100 countries, Atlas Copco is the world's largest organisation specializing in this field. Wherever you are, the international Atlas Copco Group will advise you on the applications of compressed air and provide a complete after-sales service.

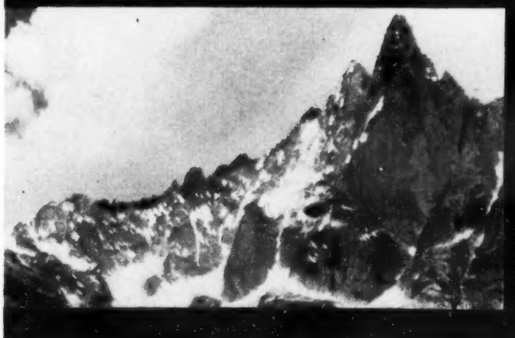
Atlas Copco puts compressed air to work for the world

SALES AND SERVICE IN OVER 100 COUNTRIES



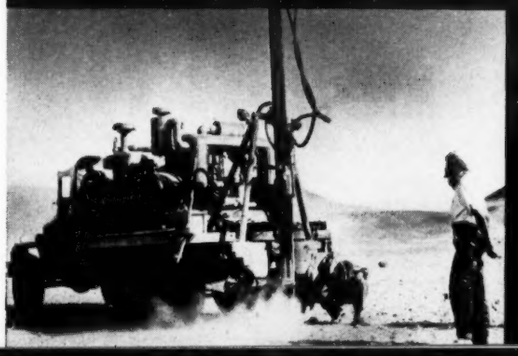
MORE POWER FOR FRANCE

The Roselend Valley project in the Savoy Alps involves building two dams and a 476,000kW power station. Atlas Copco equipment has been used almost everywhere on this project – more than 100 rock drills and many thousands of Sandvik Coromant drill steels being employed to drive the main tunnels.



THROUGH THE HEART OF MONT BLANC

When the seven-mile Mont Blanc road tunnel is completed, motorists will have an all-year-round Alpine route between France and Italy. More than half the tunnel is being driven from the Italian side with Atlas Copco rock drills and Sandvik Coromant drill steels. Power is supplied by Atlas Copco compressors.



OIL PROSPECTING IN THE SAHARA

Many of the companies prospecting for oil in the Sahara employ seismic techniques. Atlas Copco supply special equipment for drilling sounding holes. A typical unit is this Atlas Copco truck-mounted compressor – air-cooled for desert work – driving a chain-fed rock drill with Sandvik Coromant drill steels.

IC 1

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the finest big jet flying is the ***DOUGLAS DC-8***

MORE AIRLINES FLY **DOUGLAS DC-8** THAN ANY OTHER JET

MARCONI DOPPLER

IN THE ARGOSY C Mk.1

The *Armstrong-Whitworth Argosy C Mk. 1 for the Royal Air Force Transport Command will be fitted with Marconi AD2300B Doppler Navigator and Track Guide Computer.

** They will also be fitted with the Marconi AD712 Automatic Direction Finder.*

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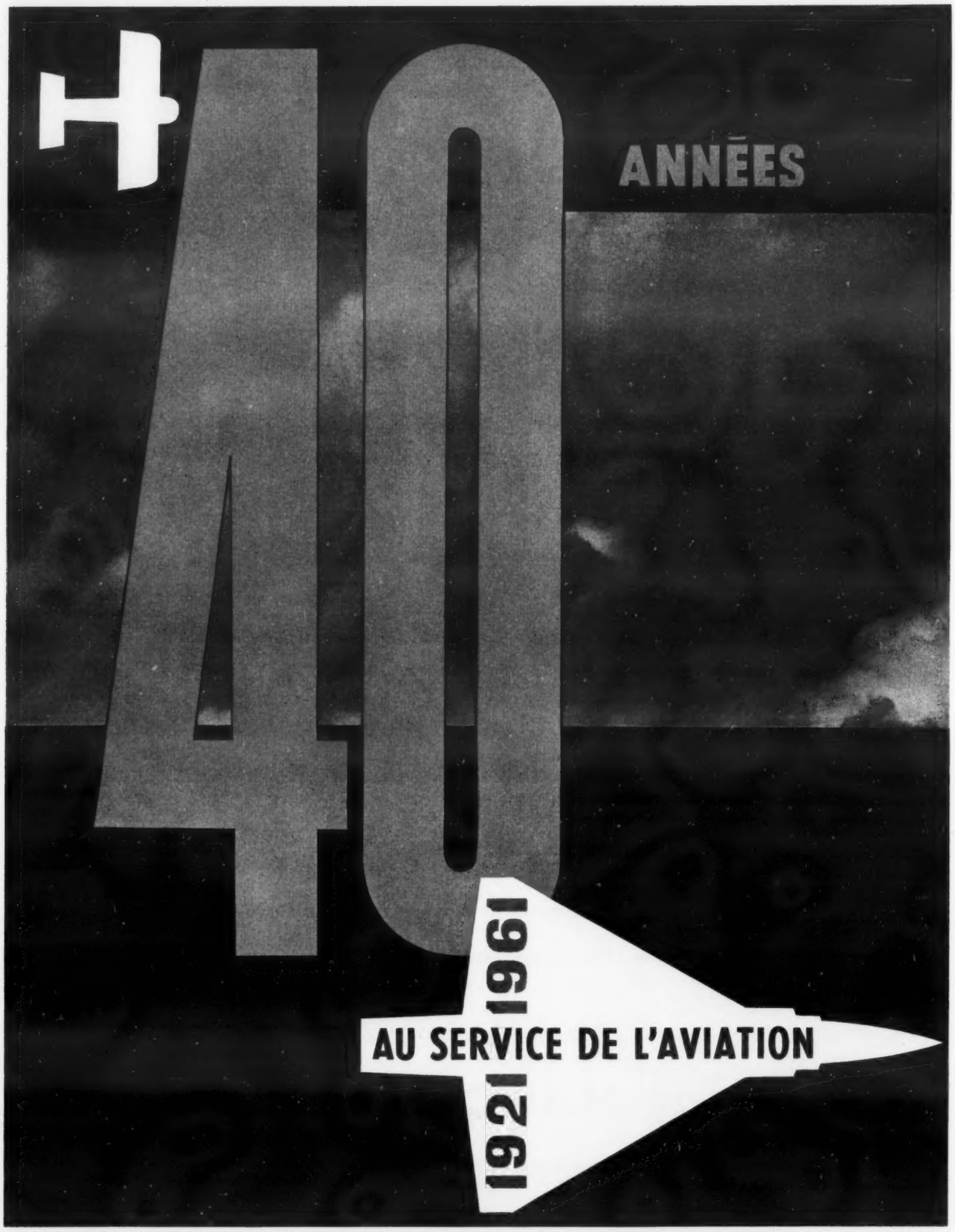

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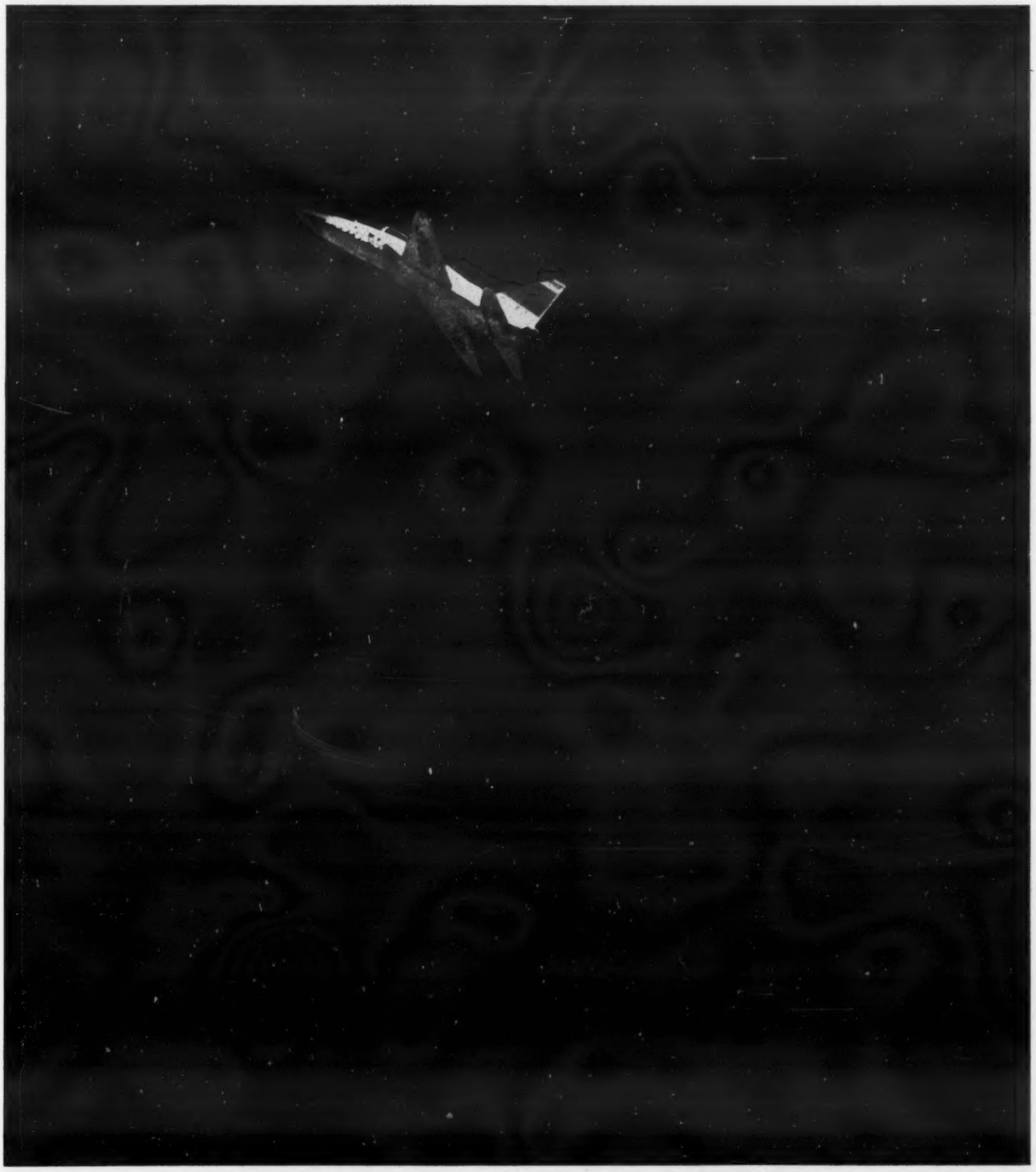
The T-38
is heading for Paris



The Northrop T-38, world's first twin-jet, supersonic trainer, will be in Paris for the 24th Salon International de l'Aeronautique, where it will demonstrate its high performance characteristics.

T-38 GUARANTEED PERFORMANCE

Speed ..... **Mach 1.2**
Ceiling ..... **55,000 feet**
Range ..... **980 nautical miles**
Rate of Climb (Sea Level) ..... **30,000 feet per minute** (at takeoff gross wt. 11,550 pounds)
Fuel Capacity ..... **580 U.S. gallons**
Propulsion ..... **Two J85-GE-5 afterburning turbojet engines**
Thrust (each engine) — 3850 pounds
Take-off Distance ..... **2400 feet**

The T-38 is already in service with the U.S. Air Force, Air Training Command.

NORTHROP
Northrop Corporation, Beverly Hills, California, USA

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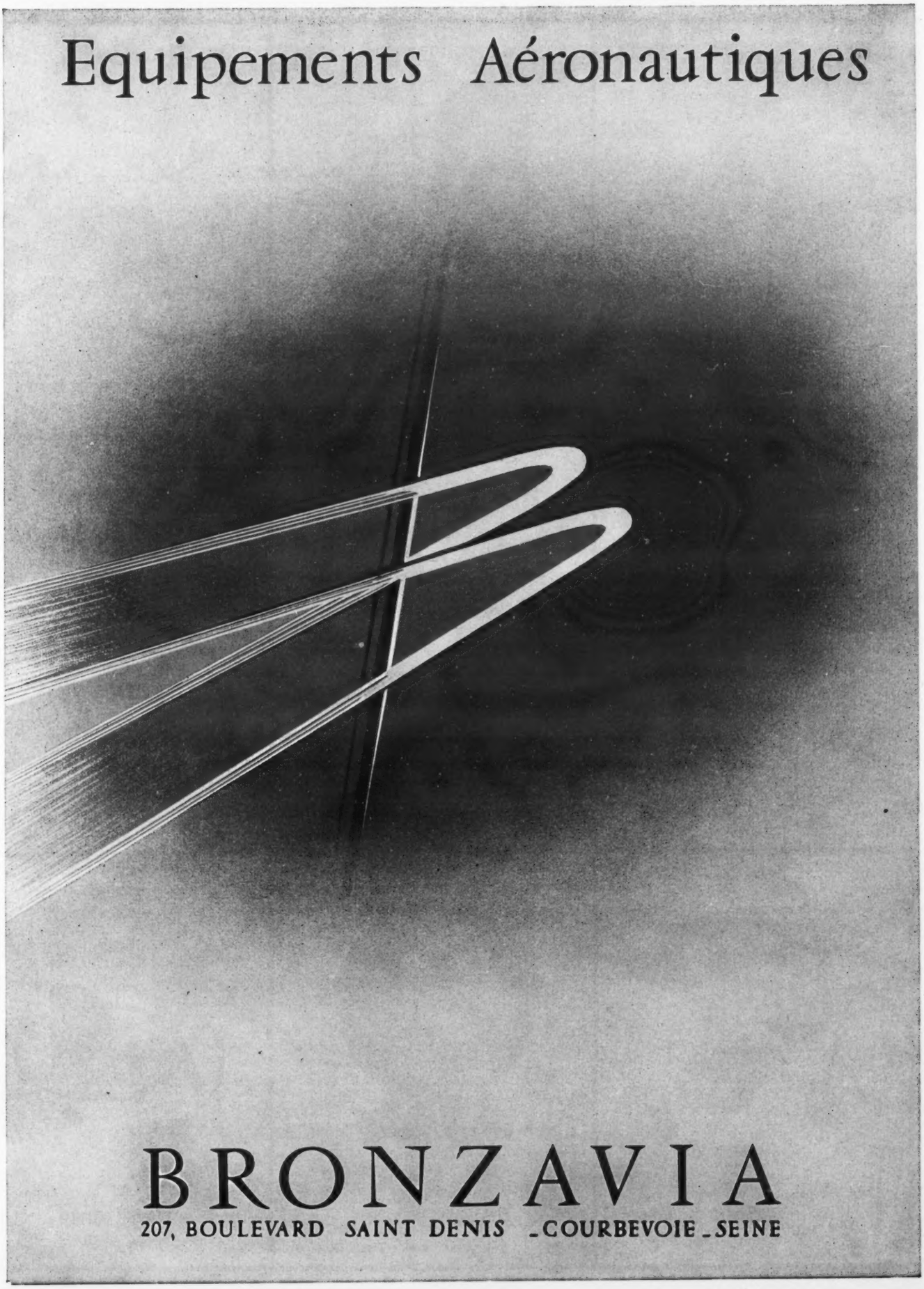
Equipements Aéronautiques



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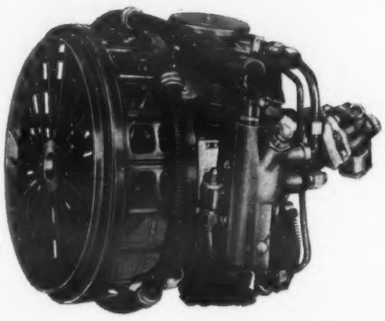
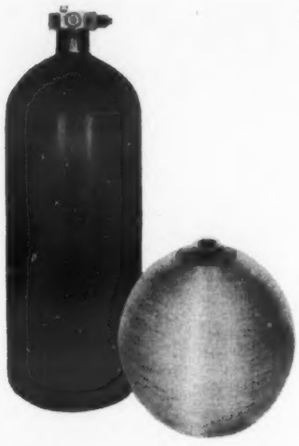
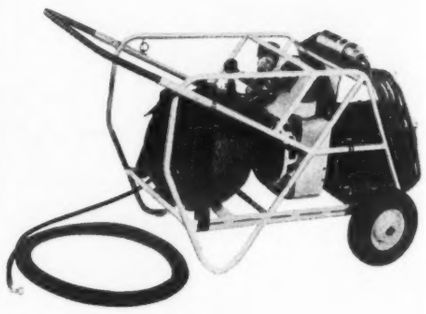


AIR COMPRESSORS



CYLINDERS AND SPHERES



GROUND SERVICE CART

PNEUMATIC EQUIPMENT

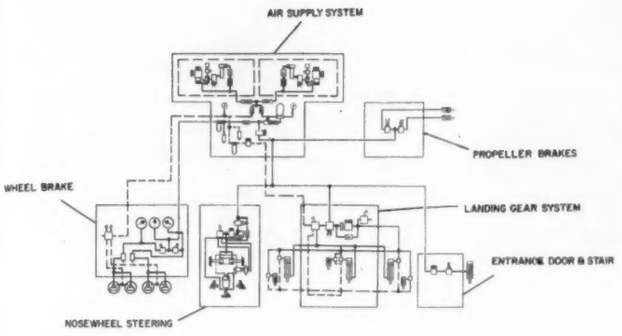
INFLATION EQUIPMENT

ACTUATOR

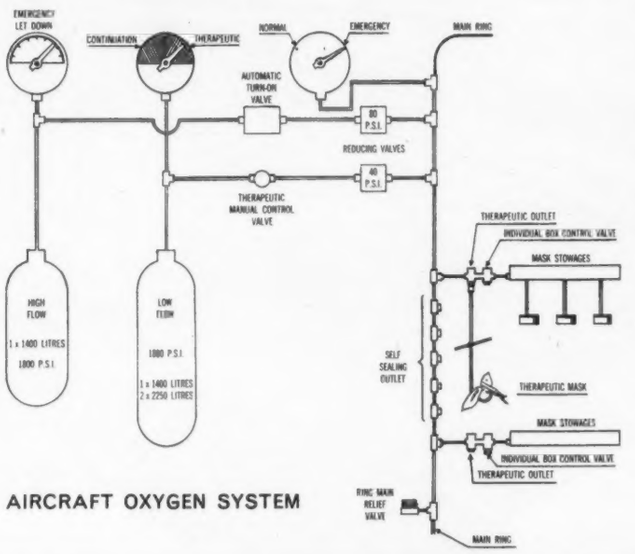
OXYGEN EQUIPMENT

FIRE EXTINGUISHING

FIRE DETECTING



AIRCRAFT PNEUMATIC SYSTEM



AIRCRAFT OXYGEN SYSTEM

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Today, nearly everything that flies depends on Kidde equipment. Reason? For more than thirty-five years, Kidde has designed and supplied the aircraft industry with the finest in dependable aviation products. Pioneers in pneumatics, Kidde today offers a complete range of systems and components, including compressors, pressure vessels, and solenoid valves. In addition, Kidde has made significant contributions to the ever-growing field of missiles and space vehicles, with the design and construction of auxiliary power sources, reaction control systems, cryogenic equipment and electronic devices. — If you have a problem in aviation system design or components, write Kidde now.

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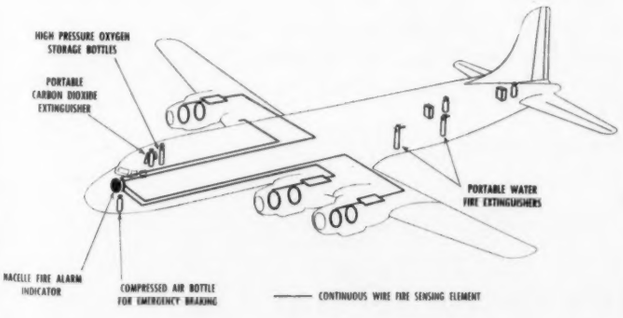
HIGH PRESSURE OXYGEN STORAGE BOTTLES
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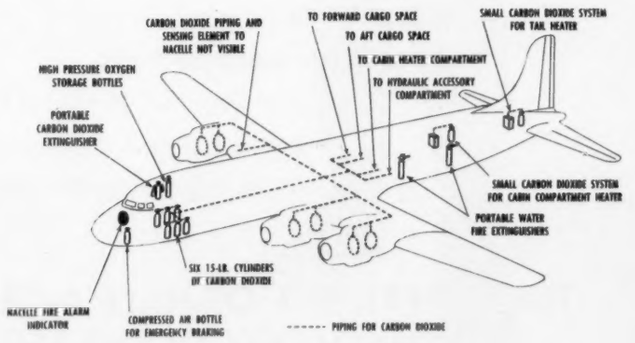
PORTABLE WATER FIRE EXTINGUISHERS
NACELLE FIRE ALARM INDICATOR
COMPRESSED AIR BOTTLE FOR EMERGENCY BRAKING
CONTINUOUS WIRE FIRE SENSING ELEMENT

FIRE DETECTION SYSTEM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TO CABIN HEATER COMPARTMENT
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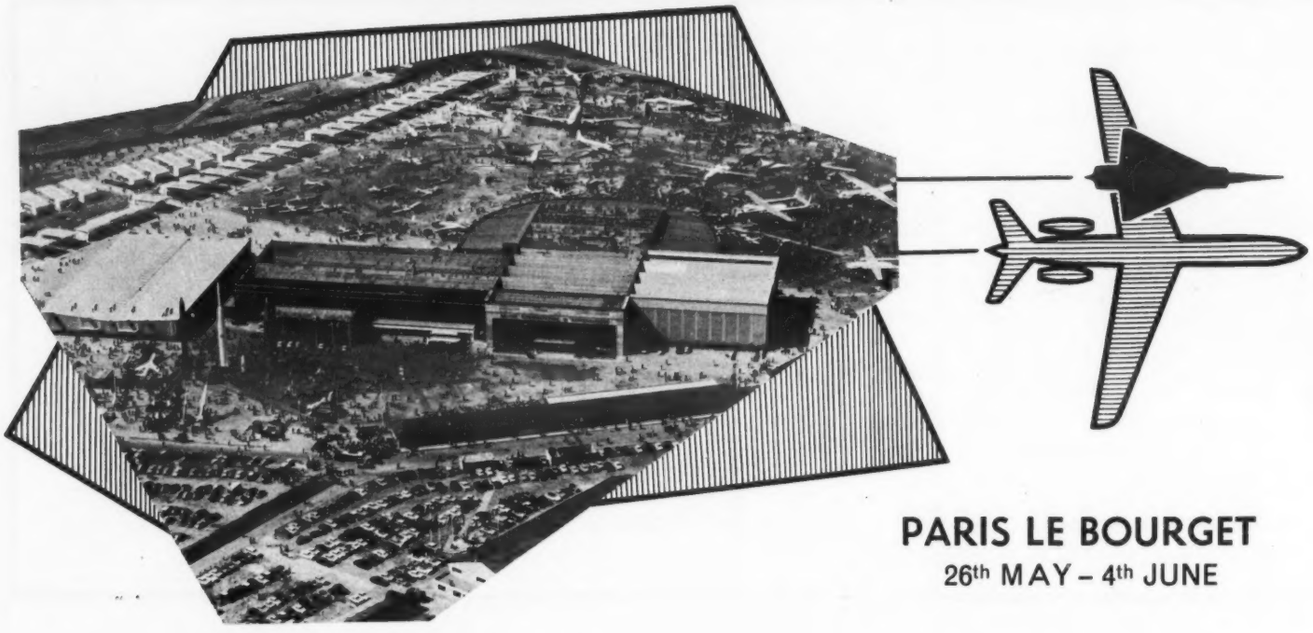
SMALL CARBON DIOXIDE SYSTEM FOR CABIN COMPARTMENT HEATER
PORTABLE WATER FIRE EXTINGUISHERS
SIX 15-LB. CYLINDERS OF CARBON DIOXIDE
NACELLE FIRE ALARM INDICATOR
COMPRESSED AIR BOTTLE FOR EMERGENCY BRAKING
PIPING FOR CARBON DIOXIDE

FIRE EXTINGUISHING SYSTEM



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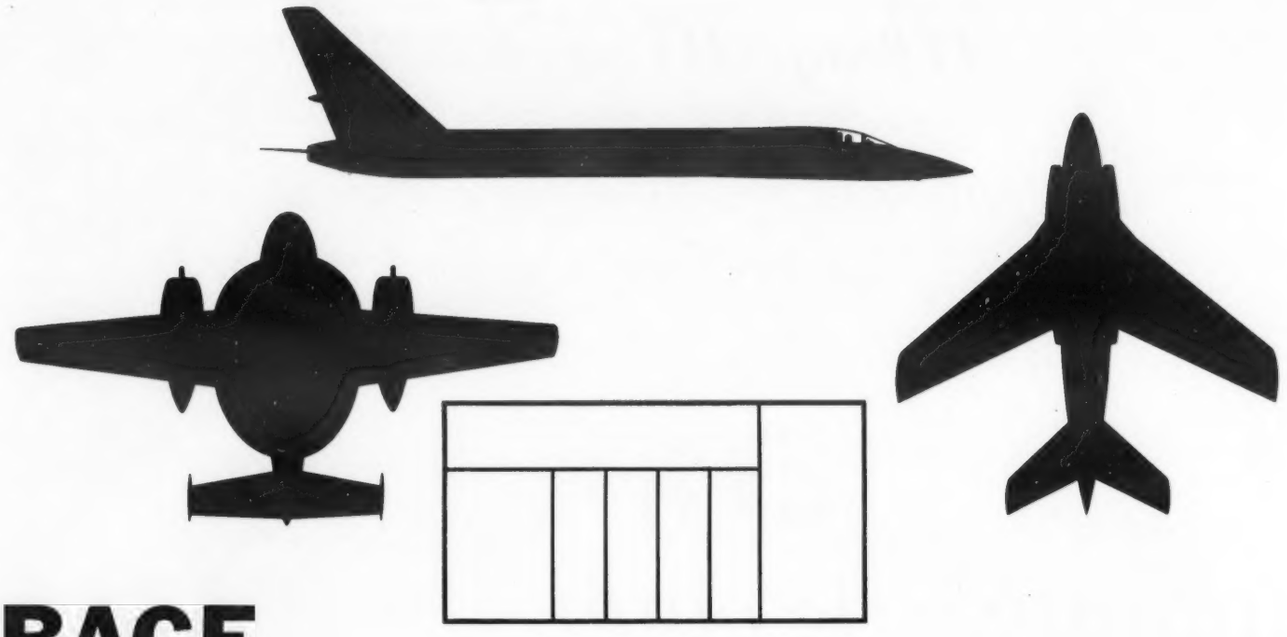

BACE

The automatic checkout equipment for advanced military systems

The Autonetics Division of North American Aviation, Inc. developed BACE to provide complete and readily-mobile automatic checkout for advanced aircraft, missiles, and other weapon systems. BACE examines and interrogates the operating relationship among major sub-systems in a weapon system. It provides absolute reproducibility of the test routine from test to test.

BACE incorporates all the necessary functions of checkout on a punched aluminum tape. All checkout data are contained on the tape. The functions of highly skilled (and often scarce) technicians are on the tape. The functions of a wide variety of manual test equipment are also on the tape. With BACE all the operator needs to know is which button to push. In this way a weapon system can be completely checked out in all operating aspects time after time without error.

In minutes BACE can perform tests and analyses which would require hours and days by conventional methods. Already being produced for use in advanced American aircraft such as the A3J Vigilante, the A2F, and the W2F, BACE is also available for use in Europe.

BACE is another of the advanced products produced by Autonetics —an international leader in electronic and electromechanical systems. Another Autonetics product now available in Europe is VERDAN, the advanced miniaturized computer for use in military systems.

BACE model will be displayed at the Paris Air Show May 26 through June 4.

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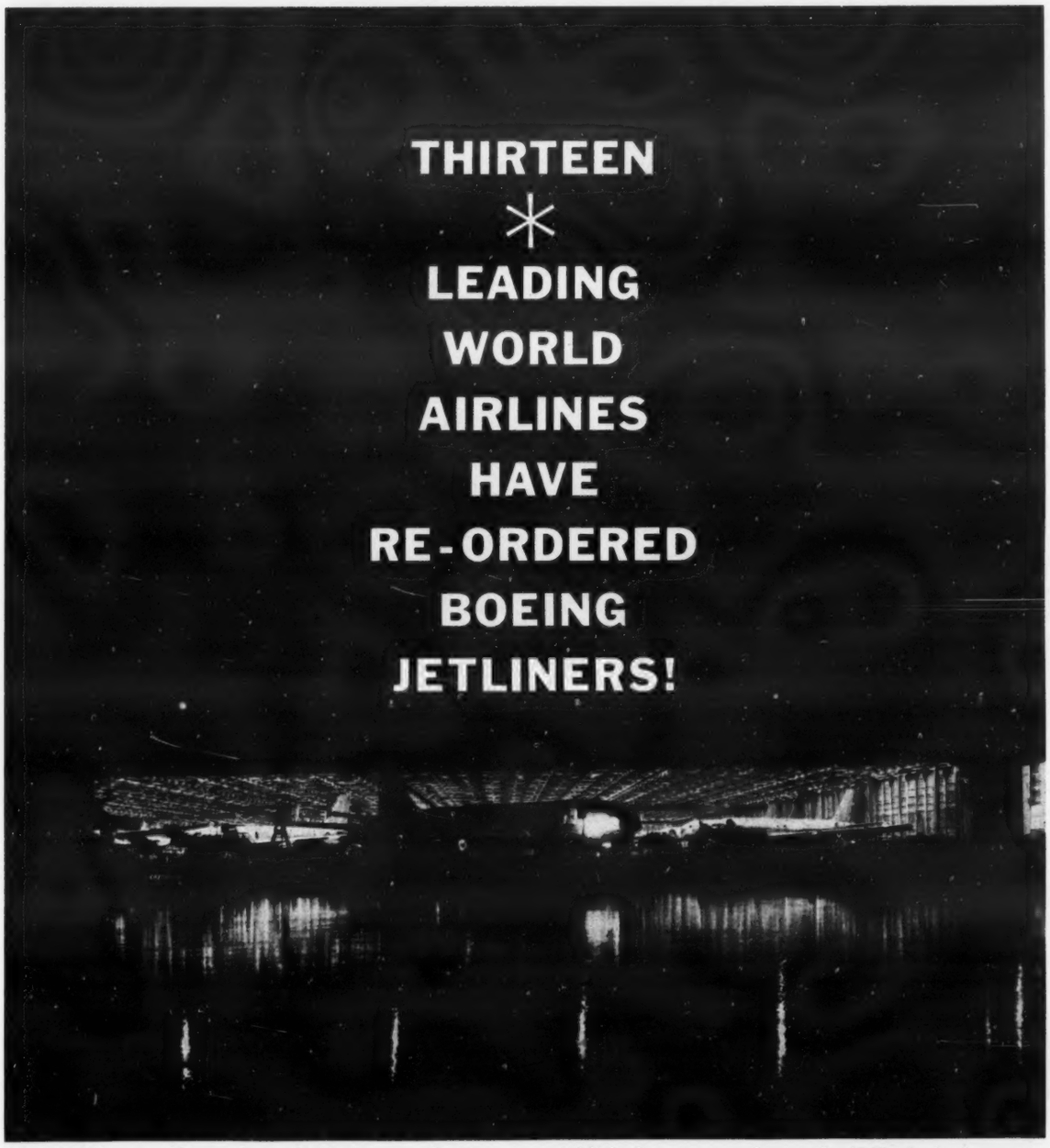

No statistic provides such authoritative proof of an aircraft's outstanding performance as *re*-orders.

Measured by this demanding yardstick, Boeing jetliners have outperformed every other jet in service . . . earning *re*-orders of 193 aircraft from 13 operating airlines.

And no wonder! Boeing jets from the first attracted such unprecedented load factors that they became the most popular airliners in aviation history. Boeing jets established more speed records (240-plus) than any other jetliner. Boeing jets have carried more passengers to more cities than any other jetliner.

These are some of the reasons more airlines have ordered — and *re*-ordered — more jetliners from Boeing than from any other manufacturer. They are also a preview of the kind of performance airlines can expect from the newly-announced short-to-medium range Boeing 727.

BOEING

* AIR FRANCE • AIR-INDIA • AMERICAN • BRANIFF • CONTINENTAL • EASTERN
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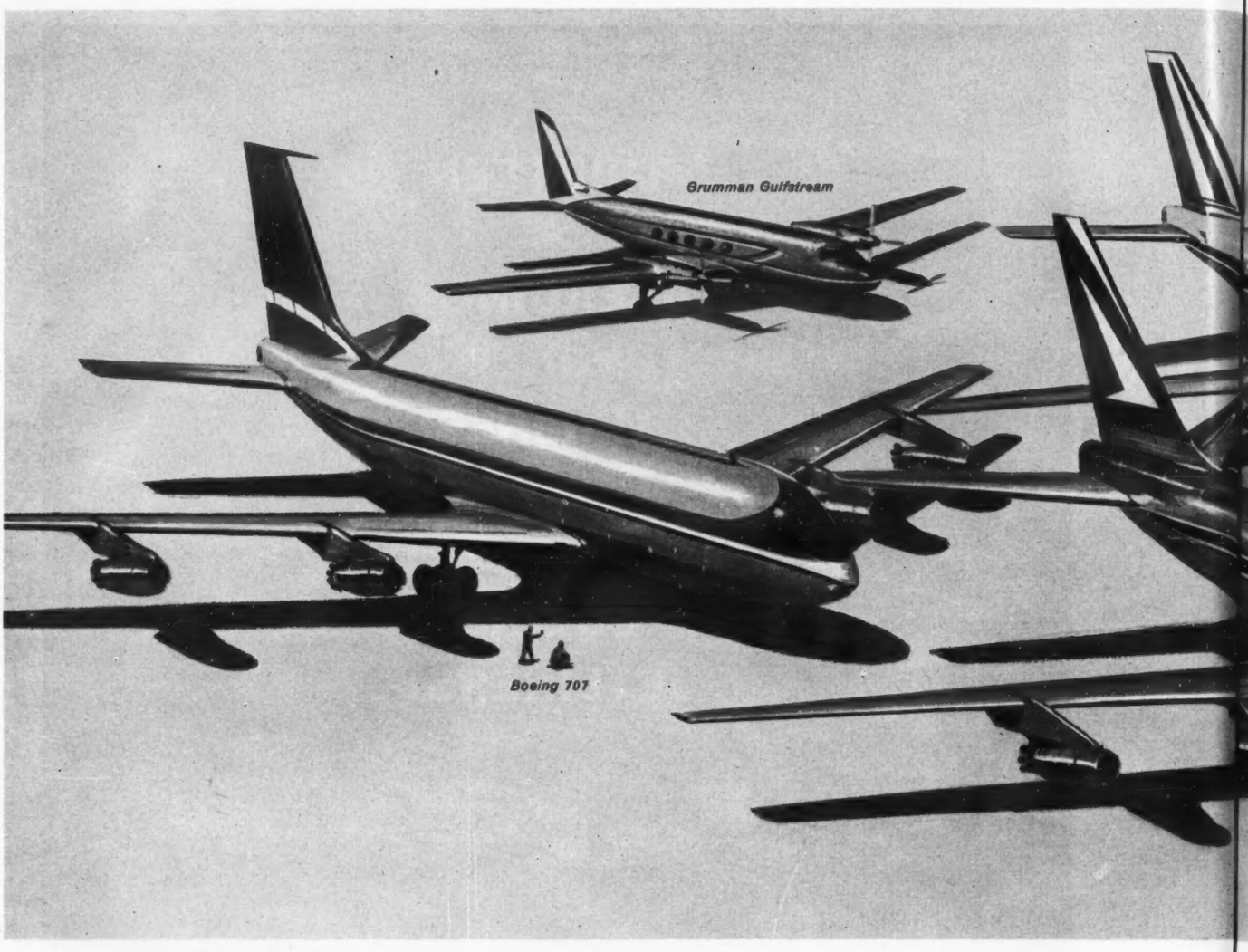


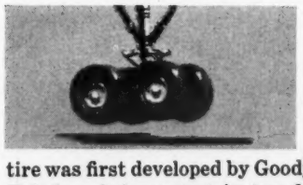
meet the supporting cast for

Across world skies these days the new jet-powered airliners are writing a proud chapter in aviation history.

Supporting the magnificent performance, comfort and safety of these "heavenly bodies" is a group of Goodyear products developed especially for their advanced requirements. They include tires able to withstand scorching high-speed take-offs and landings, powerful new brakes, and reliable skid-control devices.

While this Goodyear "supporting cast" may draw cheers from few but professional airmen, it shares credit for the matchless reliability which makes the world look up to these new jets.

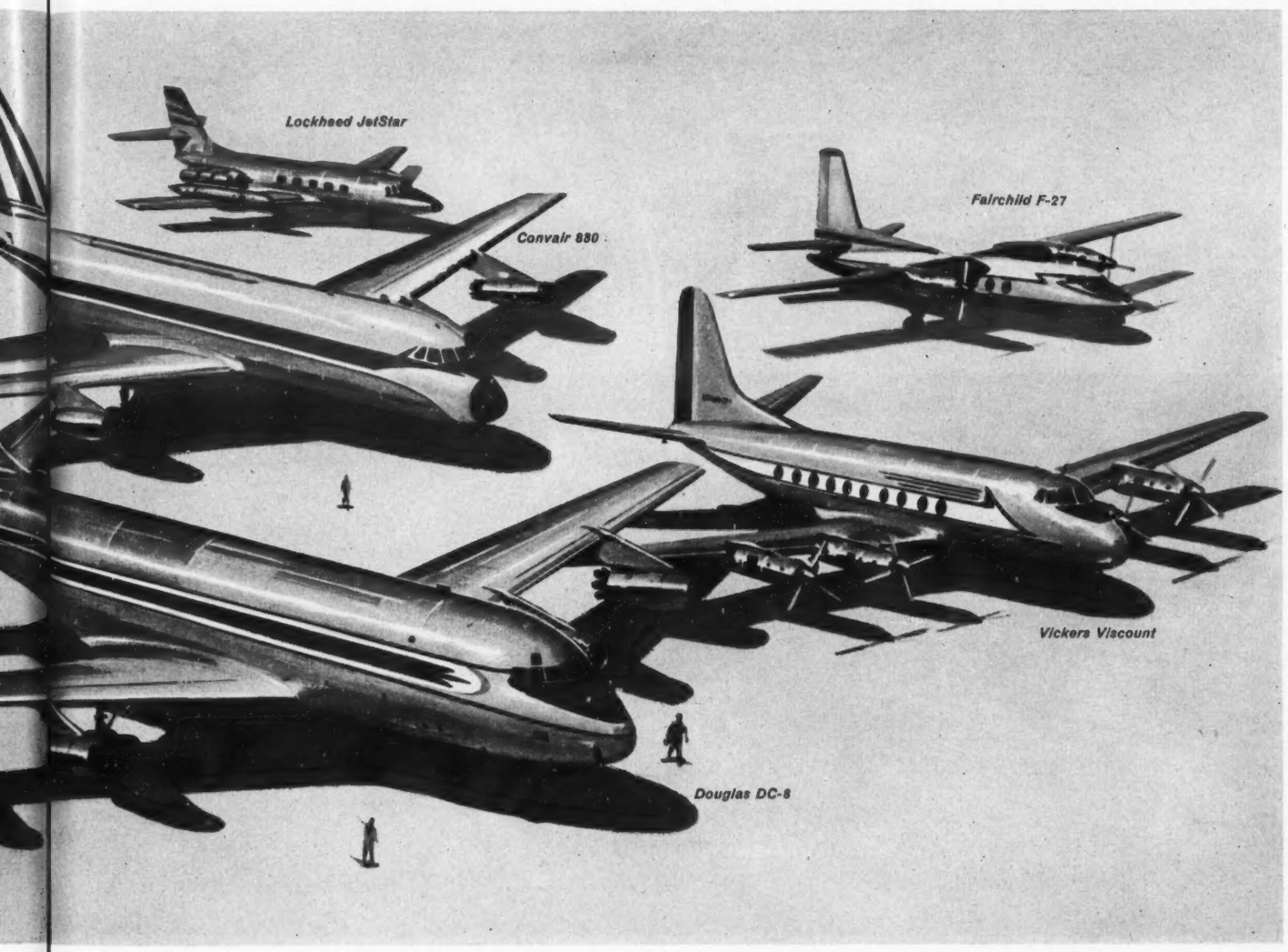
If you'd like more information on these Goodyear contributions to the Jet Age, write to Goodyear International Corporation, Aviation Products Division, Akron 16, Ohio, U.S.A.



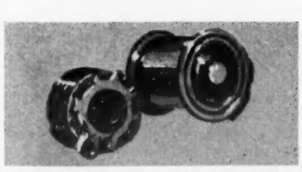
Take-off speeds between 248-320 kph with up to 136,080 kilos of jetliner are daily routine for new Goodyear fabric-reinforced tire. Noted for longer initial wear and longer retread wear, this rugged tire was first developed by Goodyear for U.S. Air Force jet fighters. Fabric reinforcement in tread reduces excessive wear caused by high-speed take-offs and landings. Airlines around the world find that this Goodyear tire delivers the extra margin of safety and dependability required by jetliners.

AVIATION PRODUCTS BY

GOOD



the sky's newest stars!



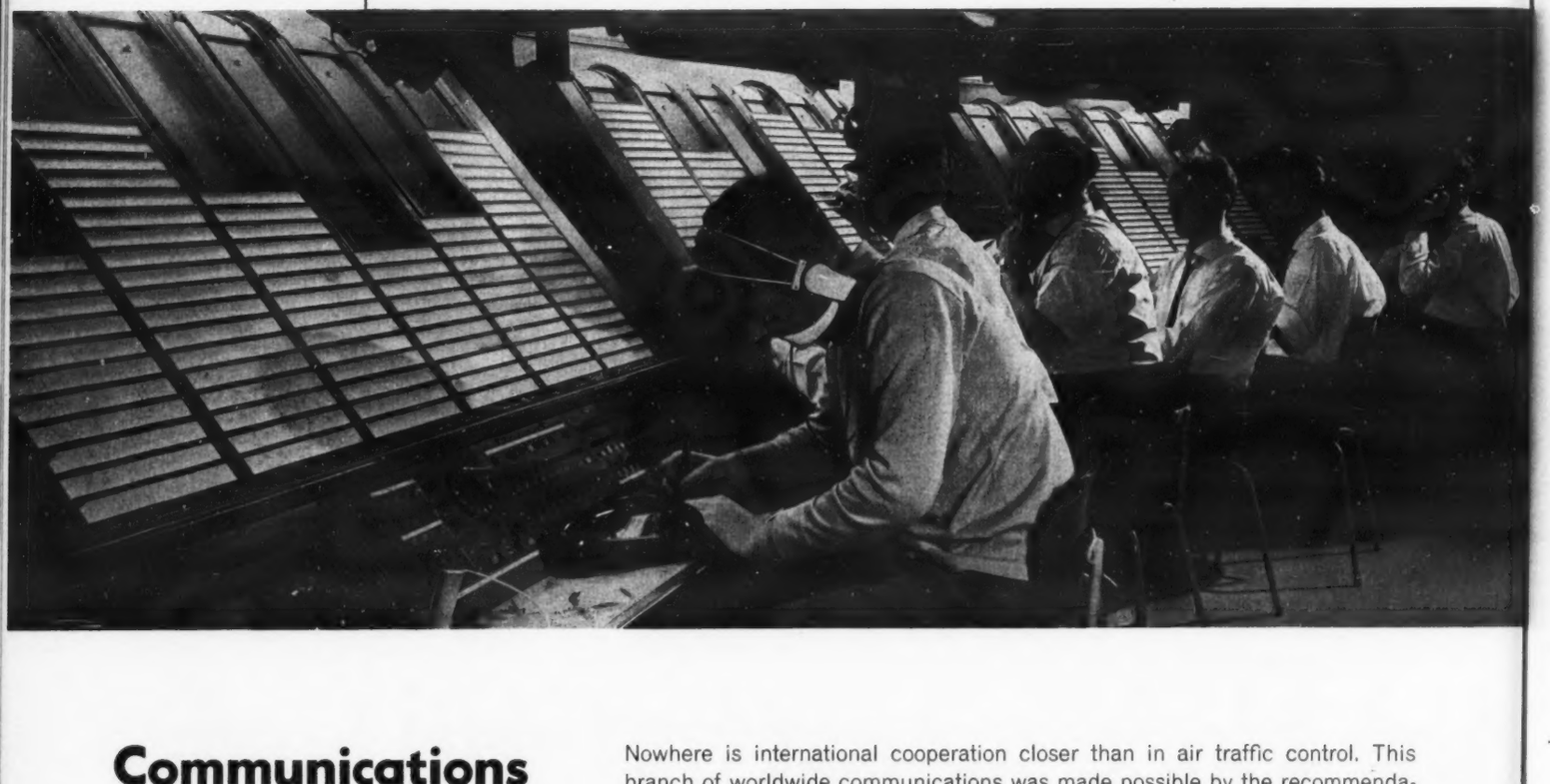
Helping carry the load of many jet-powered airliners in ground operations are Goodyear wheels and brakes. Ready for the job were the Tri-Metallic Brake and Forged Aluminum Wheel—developed especially by Goodyear to meet the high load-carrying requirements of the new jets without adding extra weight. Again in 1960, as in each of the past 20 years, more commercial airliners are equipped with Goodyear Wheels and Brakes than all other makes combined.

Avoiding a skid is essential for a giant jet landing at over 160 kph. Goodyear's Anti-Skid System helps two ways: (1) *Foot thumper system* taps pilot's shoes when any wheel is about to skid. Pilot then eases up on brake pedal. (2) *Completely automatic system* senses skid danger – releases brake pressure on about-to-skid wheel – applies pressure when danger has passed. Small and lightweight, systems can be combined as pilot-modulated system.

YEAR

More airmen land on
Goodyear tires, wheels and brakes
than on any other make

SIEMENS



Communications that know no frontiers

Nowhere is international cooperation closer than in air traffic control. This branch of worldwide communications was made possible by the recommendations of the ICAO. Air traffic control communications are carried by a vast network from Greenland to Cape Town. Telephone and teletype reports coming in over wire or radio channels from ground and flying personnel are intelligible to the members of all nations.

Increasing flying speeds and traffic density are imposing steadily increasing demands on air traffic control. Our communications equipment for control center, approach and tower combine decades of experience with current and future requirements.

Our line of air traffic control equipment includes special facilities for

Telephony
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SIEMENS & HALSKE AKTIENGESELLSCHAFT

A Plethora of Programmes

If the aerospace industries of the Western World were as generously provided with everything else as they are with programmes . . . In the two years since the last Paris Air Show, the leading manufacturers have undergone many structural changes: not only has the British aircraft industry been rationalized; in France, and even in the USA, there are signs of further mergers between firms engaged in related activities. Many hopes have been realized, many expectations have been disappointed. There have remained a growing number of programmes in all imaginable sectors of the aircraft industry, programmes for the development of aircraft, missiles and space vehicles, programmes for the production of new control and guidance systems—and programmes for the support of firms which have threatened to go aground in the execution of other programmes.

When Douglas called the DC-3 into being some thirty years ago, and even when Vickers began production of the first *Viscounts*, it appeared that aircraft manufacturers could get along quite well without "super-planning." What could formerly be done by a project leader and a handful of design engineers can today, it appears, be achieved with some difficulty only by whole staffs of defence planners and governments experts. Admittedly, when thousands of millions are spent on a single weapon project or space programme, far-sighted planning and a high degree of coordination are indispensable—although even these may not guarantee certain success. Admittedly, too, there are imposing production ventures, such as the European programme for the Lockheed F-104 supersonic single-seat fighter, dealt with elsewhere in this issue, which cannot do without a vast administrative organization. But of what use are dozens of national programmes and almost as many NATO projects, not to mention literally hundreds of programmes in hand for the U.S. defence industry, if political instability hangs over them like a sword of Damocles which can destroy them in an instant? Of what use are the most carefully elaborated concepts if despite all the impressive paper-work only a few projects come to fruition?

Fortunately, it is not the aim of the Paris Air Show to present programmes, but to create between producer and user the contacts which are indispensable to world-wide trade. But, in the light of revolutionary developments in the aviation and astronautics sectors, even this aim is becoming increasingly difficult to achieve. The Union Syndicale des Industries Aéronautiques therefore deserves particular tribute for the exemplary manner in which it has prepared the Paris Air Show, ensuring that all categories of aircraft, space vehicles and their associated equipment, both civil and military, are fittingly represented. The fact that not all the products offered are designed for civilian customers and that NATO requirements run through the show like a continuous thread, is to be ascribed mainly to the regrettable political situation at the present day. Nevertheless, the visitor to the stands will see for himself how far military developments have contributed to the creation of modern civil products. This applies to aircraft and engines, navigation and air traffic control aids, and to the field of equipment in general.

Many a visitor, lost in a wilderness of black boxes and other vital pieces of equipment, such as inertial guidance systems, electronic computers and room-size missile checkout apparatus, will feel reassured to find that some real aircraft are still on display at Paris: touring aircraft great and small, a dozen new short- and medium-haul turbine powered airliner projects and prototypes, and many more. Moreover, the fact that the official programme, as two years ago, has set aside one day for helicopters, one for air transport and one for sports and business flying, points to the continuing importance of the conventional aircraft.

When a day devoted to the supersonic airliner will finally figure on the programme, remains to be seen. For the first time, the leading aircraft manufacturers are presenting at the Paris Air Show concrete proposals for airliners with speeds many times that of sound, and even now the industrial combines which will collaborate internationally in the realization of these projects are beginning to take shape. This is a field in which a comprehensive programme is an absolute necessity.

Such planning has been, and continues to be, essential for the development of V/STOL aircraft. For years—particularly in the USA—both large and small concerns have been conducting experiments in this field. Many paths were tried, and many were found to be blind alleys. But today practical solutions are known to exist, and it is also clear that the last word in the development of VTOL aircraft rests with the engine manufacturer. In this respect, too, Le Bourget will give interesting pointers. In any case, even at the next Paris Show it is to be expected that the day devoted to the rotorcraft will be replaced by a day for VTOL vehicles of all kinds.

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While the FAI experts are racking their brains to find a yardstick by which to authenticate the recent Russian man-in-space record, the project offices of the world's aircraft industries are undauntedly continuing the projects which they have begun, each day writing a new line in the history of aviation. ←

Programme for the 24th Salon de l'Aéronautique

May 25th—June 4th, Le Bourget, Paris

Thursday, May 25th:	Preview, reserved for the industry and representatives of the French and foreign press.
Friday, May 26th:	Official Opening Ceremony.
Saturday, May 27th:	Sports and Touring Aircraft Day; Airmail Stamp Day, with issue of special stamps.
Sunday, May 28th:	Air Transport Day.
Monday, May 29th:	Aerospace Medicine Day.
Tuesday, May 30th:	Electronics Day.
Wednesday, May 31st:	Astronautics Day.
Thursday, June 1st:	Helicopter Day.
Friday, June 2nd:	Foreign Delegates Day.
Saturday, June 3rd:	International Flying Display; reserved for guests of USIA and representatives of industry, the authorities and the press.
Sunday, June 4th:	International Flying Day; open to the public.

The prototype of the GAMD *Mirage IV* supersonic bomber, powered by two SNECMA *Atar 9* jet engines, each of 13,200 lb thrust (with reheat), set a world speed record in September 1960: 1,820 km/h (1,129 m.p.h.) over a 1,000 km (620 miles) closed circuit.

The New Tasks Ahead

By General P. H. Gallois, Paris

In a world characterized by dizzy and constantly increasing speeds, where distances are becoming shorter and shorter, where ideas and cultures interpenetrate, and where there is a considerable increase in the range at the techniques to be explored, the French aviation industry is maintaining its drive and, without departing from essentials, is trying alone or in collaboration with others to tackle some of the new fields.

The French aviation industry seems to have undergone little change as compared to its state of development at the last Paris Air Show. Its annual turnover has increased by some 10%, its labour force has remained much the same, but its tooling was increased to allow construction of more modern machines, which two years ago were not beyond the prototype stage.

In spite of the continuous increase in complexity and therefore in the price of the products of the aviation industry, French aviation policy is still keeping to its aim of covering a wide sector. In the medium-range field, France has had great success with the *Caravelle* and the family of aircraft which is descended from it. Studies for a supersonic medium-range aircraft are in progress and may lead to tangible results. Operational flight at Mach 2 has been mastered, whether for medium-range operations (the *Mirage III*) or longer range (the *Mirage IV*). Other countries are turning to these aircraft, which are capable of satisfying most of the military requirements which can be put forward for the time being. The designs and aircraft produced by Breguet have been in the field of short take-off, both for civil and military purposes. Already, however, a French solution to the problems of the VTOL combat aircraft is emerging, and this will no doubt put its stamp on the next Salon. Nor has the heavy helicopter been neglected, in which field Sud Aviation intends to cap its *Alouette* successes with the high-performance *Frelon*. Lastly, in cooperation with the industry in other European countries, particularly with the German aviation industry in respect of airframes and with the United Kingdom aviation industry in respect of propulsion, France has just entered the heavy naval patrol aircraft field with the Breguet *Atlantic*, and the large-capacity transport field with the *Transall*.

This explains why the range of aircraft techniques in France today seems so wide, not of course as wide as in the USA and the USSR, but at least as wide as in Britain and much more so than in other parts of the world. The financial return is, all in all, not bad in comparison to results achieved in other countries.

As far as missiles are concerned, the French industry has been patently limiting its ambitions and has devoted itself to perfecting and mass-producing relatively simple anti-tank and air-to-air missiles, keeping the price per missile within generally acceptable limits. In this way, the Société Nationale du Nord has succeeded in gaining an international reputation for itself, and it is only very recently that both this company and the Direction des Etudes et des Fabrications d'Armement received substantial orders for the *Entac* light infantry missile.

For nearly two years, however, in other words since the last International Show in Paris, France has been endeavouring to add instruments for the conquest of space as well as long-range ballistic missiles to its armoury. Whether the efforts in question are undertaken in association with other countries, or remain temporarily on a purely national basis, the French government is fully aware of the advantages to be gained. When the celebrated wisdom of nations prevails and agreement is reached for jointly mastering the techniques which have run out of hand, the French contribution may well turn out to be far from negligible.

The French aviation industry where three roads meet

Although ill-defined and overlapping to a considerable extent, three directions in which the French aviation industry could commit itself are discernible:

1. The first, whilst the most difficult from both the technical and financial points of view, is the least difficult to follow from the political and social standpoint. This is a policy of a kind of natural self-sufficiency, keeping outside loans as restricted as possible and leaving the conquest of foreign markets to commercial competition of the classical kind. It is in fact, to a large extent, the policy followed by all the large aviation powers. As far as France is concerned, the results have been excellent, since the aircraft of foreign origin which were in use have progressively given way to French aircraft, and France has developed from an importing country into a substantial exporter. But is it possible to continue along this road? Certainly, against the background of an economy as flourishing as that of France, considering the increase in national product and the prospects which now exist of putting a stop to certain unproductive expenditure, the levels of yearly credits to the industry could be raised. But besides the fact that such investments, which have been too long neglected, would have to be authorized, and would moreover quickly take up the elbow-room in the budget, it is certain that the sums made available would not keep pace with new technical demands. When each budget comes round, a choice will have to be made, the range of project studies and production will have to be reduced and certain items retained to the complete exclusion of others. Space and its enormous demands will join the list of impossibilities already in existence, such as certain projects relating to very high powered means of propulsion, whether destined for aircraft or for missiles. It is years since, in the aviation field, a state of affairs was reached which in the political field would be "a Europe of Sovereign States." But in respect of civil aviation, as much as in the military sphere, proof is not wanting that the principle has dangerous limitations.
2. A close association between France and the United Kingdom would be capable of opening up a new road and avoiding the hazards of the previous one. It is almost a tradition in France to neglect sources of energy, and in this aviation is no exception. For nearly thirty years now, France has been a lap behind in the race to increase propulsive power. Great Britain, on the other hand, has been successfully following a dramatically opposite policy. And when, mustering her strength, Great Britain turned the corner towards missiles, she emphasized the complementary nature of the two countries' industries. To underline this interdependence is of course a truism, and to rush into it a gross over-simplification of a complex question. Nevertheless, both British and French would certainly gain by being able to meet competition in wider fields.

By-pass techniques and those required for vertical take-off seem to have been mastered in the U.K. so that, speaking on a medium-term basis, an association of this type could hardly be anything but fruitful. On the other hand, such an association would be a new factor tending to divide the nations of Western Europe and to develop competition against American techniques. A "third force" would without doubt be brought into being but, in the face of the efforts and potentialities of the communist world, surely these difficulties should be bridged in order to arrive at a sort of Atlantic community?

3. This is the argument advanced by those who favour an understanding with the USA. At the moment, of course, such an understanding is not easy to bring about. Unanimous about principles but not always about means, Washington and Paris have allowed certain differences to arise between them with resulting harm to technical agreements. But this is, after all, a question of political attitude, and the whole situation could change quickly if the two governments so wished. American progress, the all-embracing technical fields which the USA is tackling, the powerful resources at her disposal and, on the American side, the interest which she shows for the spirit of invention so often found in the old world, all speak in favour of the Paris–Washington idea. Moreover, for France, this would mean that the problems of space could be tackled without fear of arriving far too late on the scene. In regard to Western Europe itself, France's somewhat strained ties with Western Germany and its associates would be renewed through the USA. The "British solution" would carry competition into the heart of Europe; it would for example pit Franco-British achievements against those resulting from the German-American entente, whereas the "American solution" would strengthen the structure which has been shaken by the manufacture of the Lockheed F-104 and the aquisition of the Boeing 727. But this would mean an almost mortal blow for certain British techniques, and the larger the complex and the stronger the leading power, the less France would be inclined to accept integration on these lines.

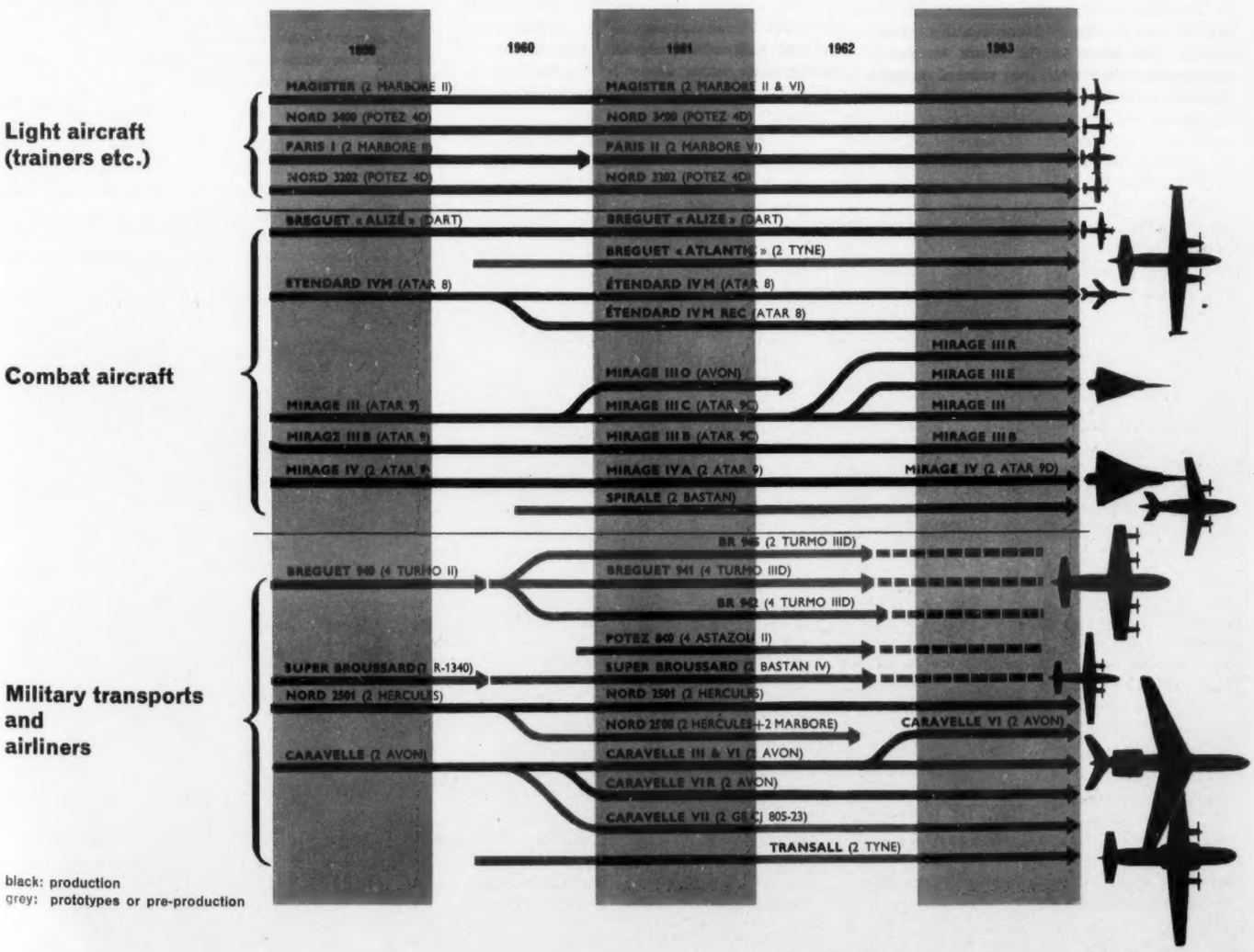
These three courses of action have their disadvantages. There is however a fourth, namely to give events and men their heads, and for France to refuse to commit herself in a determined way to any one of them. If, seven years ago, the system of standardized armaments proposed by EDC had been set up and if, three years ago, a Franco-German agreement had been made providing for joint construction of the same war material, it would doubtless still be a few years before France and Germany would find themselves together at the crossroads, and neither the problem of technical policy nor that of economic and social policy would arise today. As it is, however, there is already a question of intensifying the state of divorce by applying the industrial potential, which has been created in Western Germany for the construction of military aircraft, to the design and manufacture of civil aircraft. Should this happen, technical and industrial resources would be mobilized to compete with those already existing across the Atlantic, in Britain and in France, in markets which are already saturated by all types of aircraft. If the financial, intellectual and industrial resources of the free world are frittered away in this manner, there is no doubt as to where the benefit will go.

The tendencies behind current aircraft

Most of the aircraft to be shown at the Paris Air Show were already there in 1959. Nevertheless, technically speaking, a great distance has been covered since the last international event. If it is difficult to give a picture of the progress achieved in the course of two years, it is easy to recall the stages which are now behind us, specially in the military sphere.

1. It is first of all understood that, in Western Europe at least, there is hardly a place left for the piloted interceptor, except in a limited role of identification and, more generally, for visual control of the skies. The threat from piloted aircraft, which still exists, is to be dealt with by the ground-to-air missile. Accordingly, all the aircraft under study four or five years ago and exhibited to the public for the first time in 1957 as *defensive* machines, have become *offensive* machines. In the period between this Air Show and the last, the corresponding techniques of navigation and firing have passed from the laboratory to the testing stage, and by 1963, when the next Paris Air Show comes round, this equipment will already be in

French Aircraft from the 1959 to the 1963 Air Show



black: production
grey: prototypes or pre-production

Three 800 h.p. Turboméca *Turmo IIIBs* power the eight-ton Sud Aviation SA.3200 *Frelon* multi-purpose helicopter. Two prototypes have been undergoing flight tests for over a year and a half. Two prototypes of the SA.3210, a direct derivative of the SA.3200, will be ready by the end of 1962. In this version, the fuselage will have a rear loading door; powerplant will be three 1,300 h.p. Turboméca *Turmo IIICs*.

the hands of fighting units. In the field of electronics, the considerable effort in passing from traditional air-to-air functions to new air-to-ground functions is now successfully completed. French techniques have adapted themselves to the corresponding demands.

2. Everyone is endeavouring to "verticalize" the take-off and landing of combat and transport aircraft. The advent of the missile has had a double effect: it has taken over some of the tasks originally carried out by aircraft and, by threatening the aerodromes from which they operate, has made short, or even vertical, take-off imperative. In 1959 the Breguet experimental aircraft, fitted with 4 *Turmo* 400 h.p. turboprops, heralded the possibilities of the current Breguet 941. If the combat aircraft of tomorrow are able to land and takeoff from areas of the size of a compass swinging platform, it will also be necessary for the transports, which are indispensable for their logistical support, to be able to make do with similar facilities. It is well known that numerous STOL or VTOL cargo transport projects are under investigation in the U.K., and the new Rolls-Royce or Bristol Siddeley jet designs are being freely made use of in this connection. France is pursuing her endeavours along the path she has been exploring with propellers, boundary layer control, and high lift devices. The NATO forces are following the same pattern. In the G.91 they have a light tactical fighter which takes off from small areas, and they need a freighter to work with it. Also, since the last Salon, the French combined general staff has laid down a fresh programme, based on inter-service requirements and setting out the specification for a light transport aircraft which can be operated from a minimal area, but is nevertheless capable of transporting 1½ tons for 940 miles. Alongside the 942 with pressurized cabin for civil use, Breguet intends to answer the needs of the military strategists with an aircraft built around two *Turmo IIID* engines as used in the 4-engined 941. The competition inaugurated in connection with this new programme will certainly give rise to many more designs. There are at least 17 different ways of achieving an STOL or VTOL aircraft, and it is the most practical which have been adopted. High lift devices, reduced wing loading, high power/weight ratio and combinations of various means of propulsion are envisaged. Whereas American and German engineers, when confronted with a similar problem, availed themselves of the tilting wing and swivelling engine, French design offices have recently been ignoring principles of this kind. This is because, besides STOL—at altitude and high temperature—simplicity must be the keynote of the aircraft looked for. No doubt in 1963 we shall see the answer to this difficult specification actually in flight.

As regards combat aircraft, the choice has been made and involves vertical take-off, speed around Mach 2 at altitude, and the ability to navigate, manœuvre and fight at low level and very high speed. For nearly two years, the representatives of the NATO member States were divided on this issue, and it was impossible to reach agreement on a new generation tactical aircraft. A year ago, since the first U.S. relatively short take-off tactical aircraft programme became known in Europe, the initial projects were abandoned, the door opened to supersonic aircraft and, for certain applications, VTOL called for. The two categories of solution which are made possible by existing propulsion techniques are well known. Separation of lift and propulsion systems has been retained, and Dassault has been given an order for their design and manufacture. This occasion saw the signing of the first Franco-British agreement relating to the use of small RB.108 jets similar to those in the Short SC.1. At the same time, the use of RB.162 jets (with thrust/weight ratio twice as good as the RB.108) was envisaged for a combat aircraft, with similar specification to that of the experimental *Balzac V*, with RB.108 jets. The purpose of the Messmer-Watkinson talks, which took place last April, was no doubt to study at the highest level the various stages of closer collaboration between the two defence ministries, and probably also between the two armament industries. However that may be, we now see France deeply committed to the policy of "verticalization" of its combat aircraft. Against the background of the Franco-German agreements, the final design which France produces will be compared to that already adopted by the Bonn defence ministry, and perhaps in the end the better of the two will be adopted for interallied use.

The by-pass jet enters the lists

Less than a year ago, the public was informed that the *Caravelle* had been equipped with by-pass jets. There were various solutions which could be taken into consideration. There was the *Caravelle VII* with Rolls-Royce RB.141-3 engines, whilst General Electric was announcing the anticipated performance of a *Caravelle* equipped with CJ-805-23 jets. Early this year, there was also the *Caravelle X* with JT8-D1 engines, the subject of technical discussions between Boeing and Sud Aviation, in which some standardization of the nacelles for the jets mounted on the French medium-range aircraft and on the Boeing 727 was envisaged.

But the first B-52H production model, fitted with eight Pratt & Whitney TF-33 engines, had already made its first flight. In this way SAC acquired a longer range aircraft which does not need refuelling in flight, and the possibility of higher altitude attack coupled with the quality of near-ground level penetration, below the radar detection zone.

Higher thrust and, above all, the great improvement in specific consumption allow a considerable improvement to be envisaged in the performance of aircraft where by-pass systems replace current jet engines.

In this field too, the French aircraft industry intends to make a considerable effort. Although this is admittedly an extreme simplification, it might be said that insofar as essential military requirements were satisfied by aircraft designed to intercept at medium range only, there have been some excellent results in the *Atar* family. But as soon as very low altitude flying, coupled with the increased range necessary for offensive penetration, become normal operational demands, it is the by-pass technique which steals the thunder.

Within the framework of its agreements with Pratt & Whitney, SNECMA is working on these techniques.

Other answers are possible, and these would in their turn be within the more general context of France's intended technical policy in relation to aeronautical production. Earlier in this article we commented at length on the various solutions which are possible. In any case, as regards the propulsion of fast aircraft, a leap forward is in preparation which will, in the near future, put French aircraft on a level with that of the great producing countries.

Inter-company agreements

Since the last Paris Air Show there has been a notable tendency towards agreements between companies. Concentrations and mergers—for example the union of Sud-Ouest and Sud-Est Aviation to form Sud Aviation—were aimed at grouping the industrial resources which are today proving necessary for the design and production of heavy aircraft. To these groupings can now be added agreements between individual firms for the purpose of studying and jointly realizing special projects, the scale of which is justification for industrial agreements of this kind.

Preliminary studies for transport prototypes to cruise at supersonic speeds have already given rise to an association between GAMD and Sud Aviation. The "verticalization" of tomorrow's

combat aircraft is also based on an agreement of this type. For the building of a quantity of *Super Broussards* as part of the programme of the Secretariat à l'Aviation Civile, Max Holste reached an agreement with Nord-Aviation.

Besides these *ad hoc* agreements between French companies, there are the numerous commercial and technical agreements with foreign enterprises—American, British and German. These agreements have the advantage of being supple, in that they allow concentration of resources without the clumsiness of formal mergers.

The programme law and the aeronautical industry

It is already two years since *Interavia* commented on the general outline of the proposed bill setting out a programme for the aviation industry. Since then, the final text, which differs little from that which Engineer General Bonte had spoken about prior to the 1959 Air Show, has been submitted to parliament and approved by the National Assembly in circumstances which are well known. Design offices and factories are now working towards its progressive fulfilment.

This plan naturally took up the aircraft in course of development or production and specified the initial importance of the *Mirage III, Mirage IV, Transall, Atlantic, Etendard IVM,* and *Magister* series, as well as of different types of helicopters to be produced. The law also fixed the corresponding annual credits.

For traditional aircraft, the total sum laid down in the programme is 4,417 million new francs (i.e. less than a thousand million U.S. dollars), to be spent over five or six years. These are very modest credits, more especially as they come out of sums normally granted for national defence, of which they amount to no more than some 5% of the annual total. To these credits must be added those which are allocated for the setting up of *Hawk* ground-to-air missile battalions and the sums necessary for initiating ballistic missile engineering in France. The latter amount to 1,060 million, making a grand total of nearly 5,500 million new francs to be spent over five years, even six years for certain aircraft requiring slightly longer than the period of the 5-year plan for their production.

A Nord AS.12 air-to-surface missile mounted on a Breguet 1050 *Alizé*. Powered by a two-stage solid-propellant motor, the 165 lb AS.12 has an operating range of some 6 miles. The missile is offered in two versions: wire-guided or radio command guided. Used for surface-to-surface missions against targets at ranges of up to 4 miles, it bears the designation SS.12. Production is to begin in a few months.

In short, the programme law gives the French aeronautical industry the assurance of annual credits in respect of essential military machines of the order of 1,000 million new francs, or about half the industry's turnover. The balance, i.e. the remaining 50 percent, is to come from credits allocated for secondary items and from the export of military or civil aircraft. As can be seen, the object of the programme law was more to guarantee a minimum of credits into 1965 than to give the industry the backing for a policy of expansion, and in these circumstances it is hard to understand why there was so much opposition to the bill, and why such a lot was written about the risk of ruining the public purse.

The new organization of the French armed forces and the creation of a ministerial committee for armament have been put forward as necessarily lightening the task of fulfilling the armament plan decided on by the Government at the end of last year. It is clear that "events move swiftly" and that the tendency everywhere is towards the unification of armed forces. Hand-in-hand with the grouping under one and the same authority of all design, trial and production resources for armaments goes a similar regrouping of personnel, who will come more and more under common administration, the division into services being preserved for their employment wherever the ground, the air, or the sea imposes its particular limitations.

It is against the background of this new organization that the French aviation industry will, particularly during the next three years, translate the programme laid down by the armaments law into reality. In addition to this, there are the aircraft whose characteristics have been specified by the Secrétariat Général à l'Aviation Civile in concert with the air carriers. Apart from the modern and profitable version of the *Dakota,* which is everyone's goal, there are the *Caravelles* and their descendants and perhaps also the medium-range supersonic aircraft.

No one yet knows what the final policy will be. But on the answer depend the credits to be granted, the tools of production, and the size of the market. ⟿

With a firm order from United Air Lines for 20 *Caravelle VIRs,* Sud Aviation can be said to have successfully broken into the American market. Deliveries are to begin in June this year and to be complete in January, 1962. United has an option on a further 20 *Caravelles.*

The French Industry's Programme

By Georges Février, Interavia, Paris

It would be unfair comment to say that the post-war French aircraft industry was still in the process of growing up. The handicaps and setbacks caused by the war and the occupation have now been overcome. An industry with an export figure of 1,142,588,643 NF—a figure which will be considerably exceeded this year—and which has supplied material to numerous countries throughout the world, including even the United States and Great Britain (*Alouette* helicopters), can no longer be regarded as either a convalescent or a minor.

Furthermore, it can now devote itself for the forthcoming four years to the long-awaited programme law, which represents credits amounting to 11,790 million NF. The main features of this programme can be briefly summarized.

Special research, design, investment and manufacture of missiles (nuclear weapons and rockets for their delivery): 4,928 million NF.

Aviation equipment (aircraft, helicopters and the *Mirage IV*): 4,137 million NF.

Naval vessels, design and development of a ballistic missile by the Navy (atomic powered missile carrying submarine): 947 million NF.

Vehicles and modernization equipment for the Army: 1,778.5 million NF.

The first two items are the ones which concern the aviation industry most particularly. As regards the missiles, the organizations responsible for their development are:

– SEREB (Société d'Etude et de Réalisation d'Engins Balistiques), charged with conducting the research, design, development and manufacture.

– CEA (Commissariat à l'Energie Atomique), responsible for the design and development of the thermonuclear explosives. It includes a specialist department—DAM (Direction des Applications Militaires)—which is responsible for the research, development and construction of the warheads to carry these explosives.

– CIES (Commandement Interarmées des Engins Spéciaux), which carries out all the tests both of missiles and thermonuclear warheads.

In the field of aircraft construction, the credits cover 50 *Mirage IVs*, 270 *Mirage III* fighters, 50 *Etendard IVs*, 27 Breguet *Atlantic* long-range reconnaissance aircraft, 80 light transports (the choice has not yet been established), 70 *Magister* training aircraft and 220 helicopters of various categories.

All the companies in the industry are affected by these orders, either directly, as is the case with SEREB, Générale Aéronautique Marcel Dassault, Breguet, Potez and Sud Aviation—or as sub-contractors.

The programme will be carried out within the frame of a reorganized structure of the national defence, under the authority of General Gaston Lavaud as Chairman of the Ministerial Committee for Armaments. In effect there is no longer a Minister, Secretary of State or even Ministerial Committee for Air. Aircraft construction, like all armament construction, and also the Direction Technique et Industrielle have been placed directly under the authority of the Chairman of the Ministerial Committee for Armaments. It is anticipated that this reorganization will enable a better coordination to be attained between the various departments such as the Direction Technique et Industrielle de l'Armée de l'Air (DTI), Direction des Etudes et Fabrications d'Armement (DEFA), Direction Centrale des Constructions et Armes Navales (DCAN), Direction des Poudres and Direction des Applications Militaires de l'Energie Atomique (DAM), which supply equipment to the armed forces at present.

Two years ago, in these pages, *Interavia* regretted several lost opportunities. It is unfortunate that the *Griffon* has not been developed, as this would have enabled the research and development of the engine (a combination of an *Atar* turbojet and a Nord-Aviation ramjet) to be continued. This motor has interested the United States to the point that a design contract has been placed with Nord-Aviation. It is also unfortunate that the Fouga *Magister*, which is in service with the air forces of numerous countries, has not been developed in a supersonic version.

Although Générale Aéronautique Marcel Dassault has a lion's share in the new programme law, it can also pride itself on at least two foreign orders for the *Mirage III*, one from Australia and the other from Switzerland.

It is also known that GAMD is interested in the development of the supersonic *Caravelle* with Sud Aviation, and possibly in the production of the twin-engined turboprop M.D 415-A *Diplomate* (ex-*Communauté*).

Sud Aviation has already firm orders for more than 100 *Caravelles*, and this large company places great hopes in the derivatives of its twin-jet, which has already given magnificent proof of its capabilities with many companies throughout the world.

The *Alouette III* is already showing itself to be a worthy successor to the *Alouette II*, of which more than 700 have been ordered.

Nord Aviation, with its missiles, the SS.10, SS.11 etc., for which large orders from abroad have been received, has a further two strings to its bow. These are the production of the *Super Broussard* MH. 260 and 262 (pressurized cabin version) and, working in collaboration with Germany, development of the *Transall* freighter.

At Breguet, where a magnificent piece of European cooperation has been achieved with the *Atlantic* sea reconnaissance aircraft for NATO, great hopes are placed on the STOL 941 which will be flight demonstrated at the Show. Thanks to its short landing and steep approach performance, this aircraft can fly in all weathers and provides the regularity of operation which is the essential factor for short-haul transport.

Potez continues to produce the famous *Magister*, and has commenced construction of a small four-engined turboprop as a private venture. This aircraft, the Potez 840, will be seen in flight at Le Bourget.

When dealing with the aircraft which will be demonstrated at the exhibition, mention must also be made of the aircraft which have been equipped with Turboméca turboprop engines by SFERMA. These include the Beechcraft, Nord 1100 and the Dornier Do 27, and the installations have resulted in greatly improved performance figures. The light aircraft produced by Morane-Saulnier, the *Rallye* and *Super Rallye*, are also noteworthy, as orders have already exceeded 250 aircraft.

Turning to the engine constructors, SNECMA is producing the *Atar* engines intended for the *Mirage III*, *Mirage IV* and *Etendard IV*. The agreements concluded between the company and Pratt & Whitney enable it to face the future with confidence.

Hispano-Suiza, who builds the undercarriages for the *Caravelle* and the *Atlantic*, is to build the *Tyne* turboprops for the *Transall*.

SEPR, who constructed the rocket motor for the *Mirage III*, is carrying out extensive work in the field of liquid- and solid-propellant rockets.

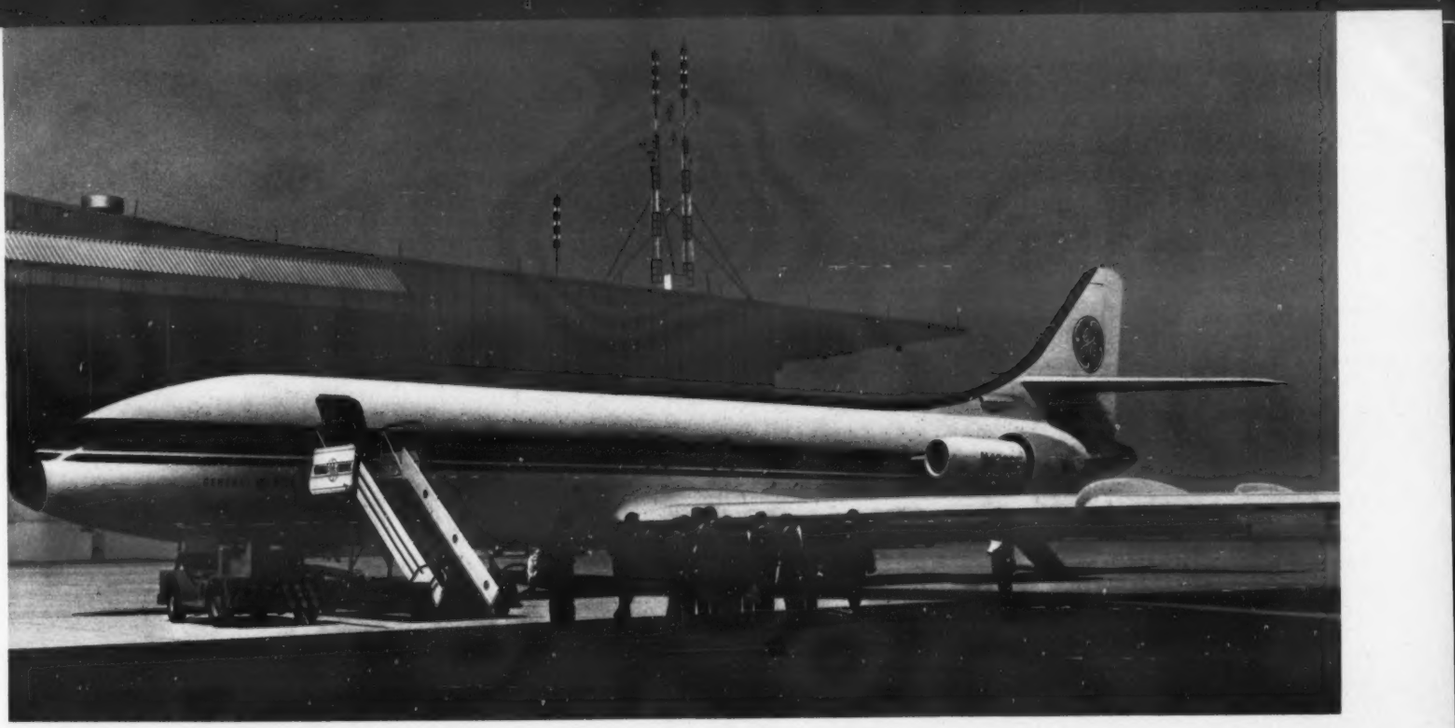
The Potez company is continuing production of engines for light aircraft (4E and 6D). These engines have shown exceptional qualities of performance and endurance.

Finally, Turboméca with the *Bastan*, *Astazou*, *Marboré* and *Turmo*, is still the specialist in small and medium power jets and turboprop engines. Messier continues to be a major constructor of undercarriages. With the exceptions quoted above, the company supplies landing gear for practically all French aircraft and also for a number of foreign aircraft (Fiat G.91 for example).

It is not possible to mention all the firms which work for the aviation industry, but with the steadily increasing part played by electronics one cannot omit companies such as Thomson-Houston, the Compagnie Française de Télégraphie Sans Fil (CSF), or Le Matériel Téléphonique (LMT). The export figures achieved by these firms for both military and civil equipment amount to hundreds of millions of NF.

Finally, among the equipment manufacturers, the Société Française d'Equipement pour la Navigation Aérienne (SFENA), the Société de Fabrication d'Instruments de Mesure (SFIM), Labinal—which has merged with La Précision Mécanique and the Société Générale d'Equipements—remain the leaders of an extremely flourishing industry with countless original ideas to its credit. ←

On November 17th, 1960 the five hundredth *Alouette II* was rolled out of Sud Aviation's La Courneuve facility. Production is continuing at a rate of 16 per month, though the line will probably be transferred to Marseilles–Marignane.



French Aviation Companies Are Confident *A Traveller's Notes*

By K. Prochazka, Interavia, Geneva

". . . Please extinguish your cigarettes and fasten your seat belts." With air brakes out, the *Caravelle* descends rapidly . . . Rising out of the haze over the city, the Eiffel Tower comes into view . . . The aircraft touches down with a gentle bump, and a few minutes later the passengers enter the new Paris-Orly terminal building. The stewardess graciously makes her farewells at the gate and leaves the passengers to their own devices. She has no need to accompany them, for the signposting is clear and "foolproof."

From the vast terraces, where the sun shines invitingly, a lonely *Constellation* can be seen on the apron amid the *Caravelles,* Boeing 707s and DC-8s, surrounded by giant refuelling trucks.

Although opinions may differ as regards many details of the terminal building, the design as a whole is characterized by the liberality and optimism which the writer was to encounter again and again in the course of his visit to the French aircraft industry.

Small missiles—large scale production

Out of Paris at speed along the Autoroute du Sud, and then the Route Nationale in the direction of the Loire. The objective: Nord-Aviation's missile factory at Bourges. Outside the town, in the middle of meadows and fields, stands a group of low buildings with nothing to show the outsider that work with high explosives is going on inside. It is explained that the reliability of powder rockets depends to a major extent on the conditions in which they are manufactured, so that in most of the assembly shops humidity must be kept below 8 p.p.m. by volume and in some even below 2 p.p.m. At the same time, the temperature must not vary more than 2 degrees from normal. This explains why all the systems in the centrally located boiler house are duplicated.

Amongst the most interesting equipment in the factory are undoubtedly the missile test rigs, where all imaginable operational conditions can be simulated, such as service handling (dropping, rolling and so on), vibration of the complete missile, and dynamic tests with the control wire, rain tests, and fuse control.

Production is now, as hitherto, concentrated mainly on the wire-guided SS.10 and SS.11 anti-tank rockets for which Nord-Aviation has secured important export orders. In addition to the anti-tank missiles, a number of air-to-air and air-to-ground missiles are in production here. In any event, the 400 employees at the plant need have no concern about the future. As we go to press, it has been announced that the American Department of Defense is about to place a substantial order for French anti-tank rockets, including the SS.11. Moreover, in a few months, the SS.12 and its air-to-ground version, the AS.12, will go into regular production. Nord-Aviation is pinning high hopes on the AS.30 air-to-ground missile, which can be fired in all flight attitudes, with the carrying aircraft at subsonic or supersonic speeds.

These new missiles are moreover said to be capable of carrying nuclear warheads, but France seems, for the time being at least, to be content with conventional explosive charges.

A wise policy of limiting development and production to a few small types has led to success in the export field and opened up important foreign markets for certain categories

The SNECMA *Atar 9D* delivers 13,200 lb thrust with reheat. At high altitudes and speeds above Mach 1.4 an additional booster system comes into operation, which raises the thrust to 15,000 lb (with reference to sea level). Two *Atar 9Ds* power the GAMD *Mirage IVA* bomber.

The new Nord AS.30 air-to-surface missile can be fired at different flight attitudes, with the carrier aircraft travelling at subsonic or supersonic speeds. The picture shows it under the wing of a *Vautour*. To the right, for comparison, is the older Nord AS.20. Technical data for the AS.30: length 12.87 ft; total weight 1,100 lb; warhead weight 506 lb; radio command guidance during powered phase, ballistic trajectory after burnout.

Surface-to-surface and air-to-surface missiles are produced at Nord-Aviation's Bourges facility. Nord-Aviation has already delivered over 50,000 guided missiles and target drones to fifteen countries. The picture shows the final assembly of SS.10 wire-guided anti-tank rockets, which are exported to the USA in large numbers.

of missile. In 1960, the French aviation industry exported its products to a value of 1,142 million new francs, 145 million of which was for missiles and drones.

A secure business

This is, without doubt, at present true of the overhauling of jet engines. SNECMA's Boulogne-Billancourt factory, working on two shifts, reached its "century" at the end of March, when the hundredth Pratt & Whitney turbojet passed through general overhaul. The main customers include Air France, whose Boeing 707s are equipped with JT4 turbojets, and the French Air Force, whose *Super Sabres* are fitted with J57s. Part of the facility is under reconstruction in order to achieve a 50% increase in the present capacity of 40 engines per month by the end of the year. Apart from jets, the overhauling of the Bristol *Hercules*, once produced by SNECMA for the *Noratlas* under licence, should provide the piston engine department with work for a long time ahead.

Whereas, under its agreement with Pratt & Whitney, SNECMA is already working intensively on the further development of American engines, the production of *Atar* turbojets is going forward. Since most of the aircraft laid down in the French defence programme law are equipped with *Atar* engines, the factory situated in the Boulevard Kellermann can reckon on substantial orders for at least two years, with the *Atar 8* (9,680 lb thrust) for 50 GAMD *Etendard IVM* carrier-borne naval fighter-reconnaissance planes and the *Atar 9* for 270 *Mirage III* supersonic single-seater fighter aircraft as well as for 50 *Mirage IV* supersonic bombers. For the sake of completeness, it should be added that two 10,000 h.p. industrial turbines—the M.33 and M.34—are under development, for which the *Atar 8* is to serve as the gas generator.

The fact that the test installations at Melun-Villaroche, which never fail to impress the visitor, have had to undergo neither major changes nor significant expansion, speaks for SNECMA's farsightedness and the liberal scale on which provision was made for experimental research. Amongst recent installations is a supersonic wind tunnel with a measurement chamber (16 in × 24 in in section) in which speeds equivalent to Mach 3 can be attained. A steam ejector pump is used for accelerating the air, and this is fed by a 8,980 cu. ft. Roots steam accumulator (pressure 250 p.s.i.), running time 2–4 minutes. The wind tunnel, which is particularly suitable for basic research into problems of compressibility and structural heating effects, is also used a great deal by the Office National d'Etudes et de Recherches Aéronautiques.

By the end of March this year a total 100 Pratt & Whitney jet engines had been overhauled at SNECMA's Boulogne-Billancourt facility; 78 of these were JT4s and JT3s for the Boeing 707s and Douglas DC-8s of various airlines, and 22 were J57s for French Air Force *Super Sabres*. On completion of a workshop which is at present under construction, the firm will be able to carry out up to 60 major overhauls of large jet engines per month.

Measurement recording techniques

On the way back from Melun, there is still time left for a detour to Massy, to take in SFIM (Société de Fabrication d'Instruments de Mesure). Here, in contrast to the giant test-rigs at SNECMA, grams, millimetres and ampères are the "big units." Production figures are, however, large. This concern was founded in 1947, but it was only after 1950 that it went gradually into full production, and output to date amounts to 20,000 potentiometers, 20,000 other detectors, 7,000 photographic recorders, 3,000 oxygen regulators, 1,000 artificial horizons, 1,000 radio compasses and 600 transmitters for long range data transmission.

If the activity of SFIM in the first years of its existence was confinded to the development of measurement instruments and measurement transmission equipment, as required mainly for flight testing purposes, 50 percent of its today's activity relates to instruments for aircraft in regular production. We learn that most French models have SFIM instruments, for example the *Vautour, Magister, Broussard, Alizé, Etendard, Mirage* and *Frelon*. In addition, exports to U.K., Italy, Germany, Australia and Israel are substantial.

Despite repeated expansion of the production shops in the last few years, the management was recently obliged to start building again. And this will not be the last time. The research and development department, which accounts for 15 percent of the employees, will see to that.

Many-sided activities at Bois-Colombes

Jet engines, turboprops, rocket motors, undercarriages, hydraulic pumps and motors, reduction gears, ejection seats and control systems for nuclear reactors are all on Hispano-Suiza's production programme. This factory, which can look back on a fine tradition in aero-engine construction, has during the last few years been responsible for notable developments in the field of undercarriages, and Hispano-Suiza is the acknowledged pioneer in forged undercarriage parts. In cooperation with the metal industry, it proved possible to develop forging processes for geometrically complicated light alloy parts which require machining. Hispano-Suiza is also devoting itself to the development of wheels and brakes, this partly on the basis of licences from Dunlop

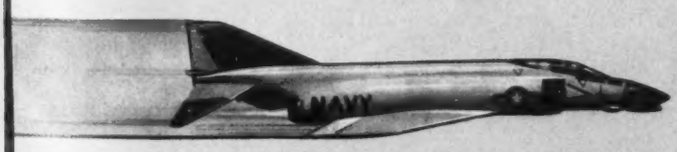
A PHANTOM

These are the wings of a unique aircraft—Phantom II. They are sharply tapered, sharply swept and extremely thin. They are an important example of highly advanced aerodynamic design.

In over-all performance the wing design of the Phantom II enables it to operate from short fields and carrier decks and fly to a height of 98,560 feet—and still attain a level-flight speed of over 1500 mph.

The wings of the Phantom II are not merely airfoils. For solid aerodynamic stability above Mach 2, the outer panels of the knife-like foils sweep up at a dihedral of 12 degrees. Both leading and trailing edge flaps, augmented by boundary layer control, assure greatly increased lift for take-off and landing. The ailerons and spoilers provide a high degree of lateral control—for ground attack operations, for low approach speeds and for maneuvering at extreme altitudes.

Altitude, speed and weapon-carrying capabilities have been combined in the Phantom II to a degree never before achieved in a combat aircraft. Now in production, the Phantom II offers flexible operational and armament capabilities for either police action or total war deterrence. The most versatile combat aircraft in existence—and the one with the highest performance—the Phantom II insures maximum defense for every defense dollar.



MCDONNELL

Phantom II and F-101 Fighter and Strike Aircraft •
Project Mercury Space Capsules • Talos Airframes and Propulsion Systems •
Quail Decoy Missiles • Rotorcraft • Electronics Systems • Automation

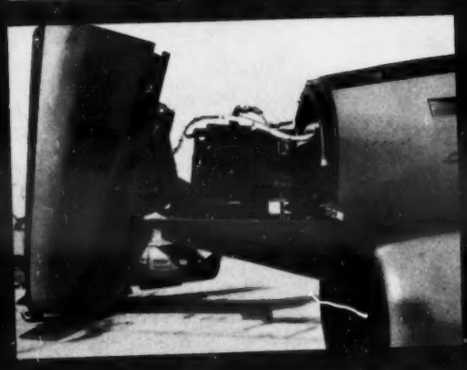
MCDONNELL AIRCRAFT ST. LOUIS, MISSOURI, U.S.A.

Fiat G91T

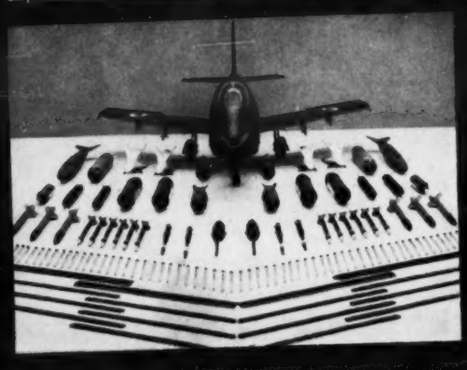
Pilot seats

Patrol on a training flight

Rapid refuelling



Photographic equipment



Combinations of weapons

TRAINING

Universal trainer which can take the pilot from the flight simulator to the simulated military mission

OPERATIONAL EMPLOYMENT

Retains all the main characteristics and possibilities of the single-seat fighter and can thus be used as a light tactical support aircraft

FIAT — DIVISIONE AVIAZIONE — Corso Giovanni Agnelli 200 — Turin (Italy)

Aircraft Engine Division
Workshop with FIAT 4023.002
engines in construction
Bristol Siddeley Orpheus 80302

Aircraft Division
G 91 R assembly workshop

Aircraft Engine Division
Jet engines being overhauled
and repaired

Sangone workshops
Turbojet test facility

Caselle workshops
Jet aircraft being overhauled
and repaired

Fiat Aviazione

LEAR
OZARK
FINNAIR
ALLEGHENY
PIEDMONT Airlines
ROYAL AIR MAROC
NEW YORK AIRWAYS
SWISSAIR
SABENA
VARIG
ALITALIA
UNITED AIR LINES
NATO
Lear
SANTA MONICA, CALIFORNIA, U.S.A. · MUNICH, WEST GERMANY · GENEVA, SWITZERLAND

and Bendix. Increasing aircraft weights and landing speeds on the one hand, and the necessity of short runways on the other, make maximum demands on the efficiency of brakes. A new development has made it possible to raise the work capacity from 172,280 ft lb to 246,400 ft lb per lb of brake drum weight.

A few weeks ago, the first undercarriage for the Breguet 1150 *Atlantic* was delivered, and at time of going to press, the second is practically ready. The output of undercarriages for the *Caravelle* is at present 5 complete sets per month, and about 100 have already been delivered.

In this age of automation, there is also a demand for hydraulic equipment outside the aircraft industry. Hispano-Suiza is building hydraulic motors and pumps for outputs of 5½, 11, 22, 44 and recently 88 Imp. gallons per minute. The items in production for aircraft systems also include auto-regulating pumps (pressure 4,200 p.s.i., outputs 1⅓ to 20 gallons per minute), hydraulic motors, distributor valves, "Hydro-standard" components for hydraulic equipment and other similar components.

Hispano-Suiza has for years had close relations with Rolls-Royce. The *Tay* and *Nene* jet engines have been produced under licence, and in September 1960 the French concern received construction rights for the *Tyne* turboprop which, as is known, is intended as the engine for the *Atlantic* and *Transall*. At present, however, priority must be given to overhaul of the *Derwent*, *Avon* and *Marboré* engines together with repairs and spare part production for the *Nene*, *Tay* and *Verdon*.

Versatility is the keynote. For instance, in a small shop, ejection seats are being produced for the account of the Société d'Exploitation des Matériels Martin Baker, in which Hispano-Suiza has a financial interest. The seats are for installation in the *Mirage IIIC*, for which this concern is also producing SEPR 841 rocket motors.

Prototypes at Toulouse-Colomiers

In the South of France, Breguet's new offshoot at Toulouse-Colomiers is the first port of call. Six months ago, large premises were built here in the record time of 3 months; for the time being these are for prototype assembly, but they can be adapted for series production at any time.

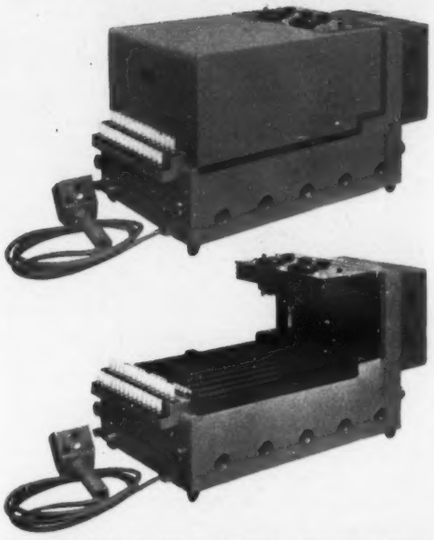
Work is going on at high pressure to ensure that the Breguet 941 is in readiness to fly at the Paris Air Show. To speed up the testing of the propulsion system, Breguet has set up a mobile test rig, on which the wing, engines, synchronization system and part of the cockpit destined for the second prototype have been mounted. By the time this issue appears, tests should already be in progress. Propeller synchronization has been much simplified as compared with the Breguet 940; in the 941 each engine now has one reduction gear instead of three as before. Breguet undoubtedly sets great store by the lift wing principle, as is shown by the mock-up of the 942, a pressurized civil 50–55 passenger version of the Breguet 941, which will be exhibited at the Paris Air Show. Apart from the fuselage, the two types exhibit few differences; the wings are the same, likewise the 20 ton take-off weight, the 4 Turboméca *Turmo IIID* turboprops each of 1,250 h.p. take-off rating with Ratier-Figeac adjustable propellers, and both the 941 and 942 have similar *Jockey* undercarriages by Messier.

The "small" Breguet 945 (two *Turmo IIID* engines) belongs to the same family. This aircraft has a 10 ton take-off weight, and is reported to carry a 1½ ton payload for 940 miles at 250 m.p.h. For use as a light transport in the battle area, the 945 is in competition with the Dassault *Super Communauté* and Nord-Max Holste *Super Broussard* and would be one of the possible choices for NATO if a tender is opened for an aircraft of this type. Breguet stresses that the main advantage of this aircraft is the safety in operation offered by the proposed combination of two engines with four interlinked propellers, since the remaining propulsive power can be distributed to the four propellers even if one engine is out of action—an advantage which, in Breguet's view, more than compensates for the intricate nature of the powerplant installation.

A few yards away from the 941, the two prototypes of the *Atlantic* are coming into being. Strict silence is, however, maintained about these aircraft, with the exception of their principal measurements.

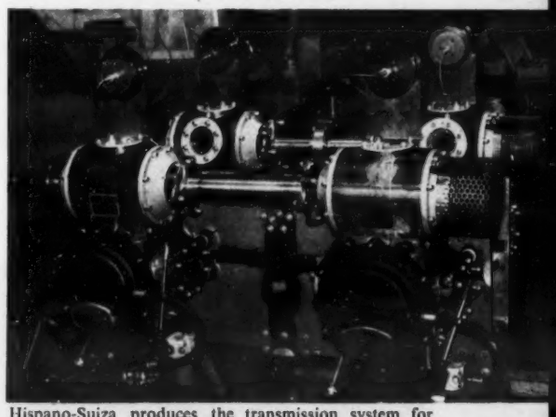
A new short-range model

At Potez-Air Fouga, on the other side of Toulouse airfield, the Potez 840 is at present the main topic of conversation. As this article goes to press, this new short-range aircraft is on the point of making its first flight.



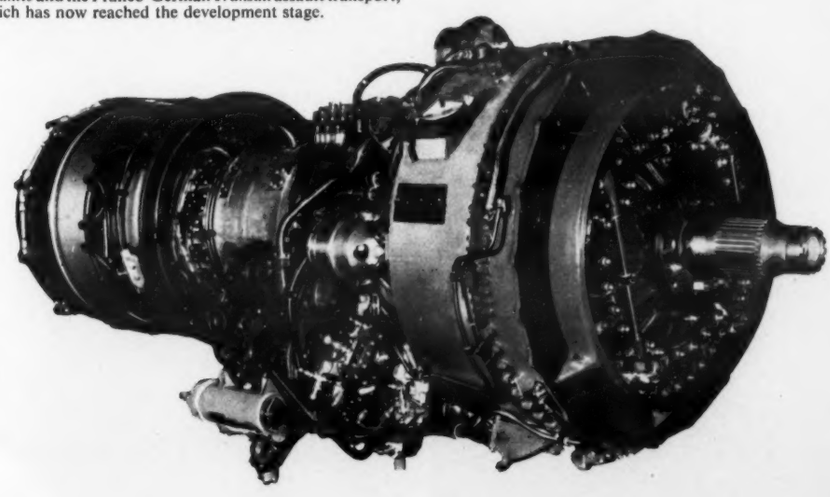
Type AO 10 photographic recording equipment produced by SFIM (Société de Fabrication d'Instruments de Mesure) under licence to ONERA. The equipment weighs 132 lb and can record up to 25 data simultaneously. Film speed up to 40 i.p.s.; film length 165 ft.

The SFIM 14050 gyro platform with horizontal and directional gyros is part of the Bezu-SFIM type 151 heading and attitude indicator, installed in the GAMD *Mirage IIIC* combat aircraft. Technical data: overall length 14.1 in.; weight 16.06 lb; deviation of the heading gyro in flight 1–3°/h; data transmitted reliably at roll rates of up to 400°/sec and pitch rates of up to 120°/sec.



Hispano-Suiza produces the transmission system for synchronization of the Breguet 941's propellers.

Hispano-Suiza will produce the *Tyne* propeller turbine under Rolls-Royce licence for installation in the Breguet *Atlantic* and the Franco-German *Transall* assault transport, which has now reached the development stage.



Another prototype is under construction at the Argenteuil facility and will satisfy the American certification regulations. In answer to the writer's questions as to why the 4 engines each of 530 h.p. take-off rating could not be replaced by two engines of roughly double rating, it was pointed out that this was principally due to aerodynamic considerations. In the case of 4 propellers, the major part of the wing lies in the propeller slipstream so that, with the double slotted flaps extended, maximum lift coefficient can be achieved.

Breguet built this new assembly hall at Toulouse–Colomiers last autumn in record time. At present used for building prototypes, the hall, which is 264 ft wide and 125 ft deep, can be easily extended to cover many times its present area, and can be equipped for quantity production.

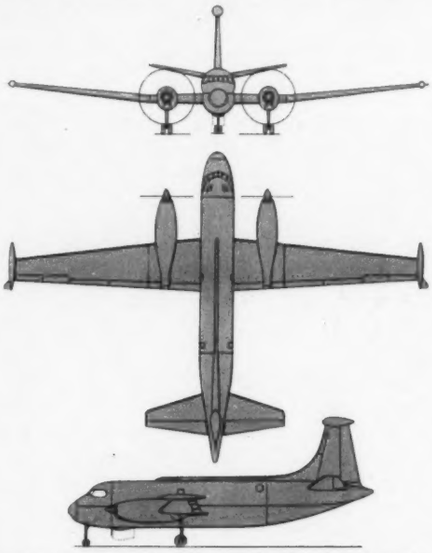
At the Potez stand at Le Bourget, enquiries will be welcomed and detailed information about the conception behind the design gladly given.

Standard equipment of the Potez 840 includes two VHF transmitter/receivers, a Collins VOR, an ILS with radio altimeter, a CSF radio compass and a Lear flight director.

Production of the *Magister* is being maintained at 4 per month, with orders for 125 aircraft still on the books. Counting all variations (e.g. the CM.175 *Zéphyr*), orders for 720 *Magister* aircraft have so far been booked, 450 by Potez itself and the remainder by foreign concerns producing under licence. In its latest version, equipped with two Turboméca *Marboré VI* turbojets each 1,060 lb thrust, the *Magister* has achieved a maximum speed of 445 m.p.h. in horizontal flight, a service ceiling of 44,500 ft and a climbing speed at sea level of 3,660 f.p.m.

The name Potez will also appear elsewhere at the Show, namely on the stand of Ernst Heinkel Flugzeugbau GmbH, which has developed the Potez-Heinkel CM.191 4-seat tourist and liaison aircraft from the CM.170. Heinkel took over construction of the prototype and has acquired production and selling rights for all countries (except France, Algeria, Tunis, Morocco and the French Community where they are reserved by Potez).

Engine development is also being pursued. After a pre-production of 10 units, full production of the 4E 4-cylinder, horizontally opposed engine started. This engine weighs 202 lb with a take-off rating of 105 h.p.; in continuous operation the engine develops 75 h.p. with a consumption of 0.5 lb/hp/h. At the request of the training and clubs division of the Secrétariat Général à l'Aviation Civile, the engine was recently installed in a Scintex CP.301C *Emeraude*.



Three-view drawing of the future NATO naval reconnaissance and ASW aircraft, the Breguet 1150 *Atlantic*. Powered by two 6,000 h.p. Rolls-Royce *Tyne* propeller turbines, the *Atlantic* will have a cruising speed of some 400 m.p.h. and will be able to stay in the air for at least twelve hours. Two prototypes are at present under construction at Breguet's Toulouse–Colomiers facility.

To enable the new transmission system for the 941 to be tested independently of the first prototype, Breguet has built a mobile test stand at Toulouse, on which the wing for the second prototype has been mounted, together with all the assemblies belonging to the powerplant, including the appropriate cockpit instruments and controls.

Prototype of the Breguet 941 STOL transport, which will be demonstrated in flight at the Paris Air Show unless unexpected delays are encountered.

The Caravelle for the USA

The *Caravelle VIR*, in the colours of United Air Lines, can be seen on the Sud Aviation's apron at Toulouse-St. Martin, where it is at present undergoing accelerated flight testing. The production programme calls for the twenty aircraft, equipped with Rolls-Royce *Avon 533 R* and thrust reversers, to be delivered by January 1962 in fulfilment of UAL's order. On March 31st 1961, firm orders had been received for 116 units (65 of which had already been delivered), plus options for a further 29 (including 20 for UAL alone). Whilst production continues unchanged at the rate of 4 aircraft completed each month, the design office is intensively at work on Version X, for which the engines are to be 2 Pratt & Whitney JT8-D1 turbofans, each 14,000 lb thrust. SNECMA has developed a nacelle for this engine with thrust reversal system and has also offered the design to Boeing for the 727. At time of going to press, the latest data for the *Caravelle X* were: Maximum take-off weight 109,200 lb, take-off distance 6,700 ft; maximum cruising speed 512 m.p.h.; range 2,075 miles with 17,600 lb payload, alternatively 2,430 miles with a payload of 14,150 lb; price about 17½ million NF. Sud Aviation is counting on finding interest for the *Caravelle* on the part of airlines who have given, or intend to give, orders for Boeing 727s, since both types are fitted with the same engines.

Since December 30th, 1960, the *Caravelle VII* re-equipped by General Electric with CJ-805-23 aft-fan engines has been undergoing flight tests in the USA. In support of the sales effort for this model, Sud Aviation has laid down in addition to the original prototype (in the case of one already flying the airframe is that of the *Caravelle III*) a further four *Caravelle VIIs*.

Whereas, therefore, the take-off weight, range and speed of the *Caravelle* have been increasing step by step, particularly with an eye to the USA market, the *Caravelle Junior* project is, to some extent at least, a shot in the other direction, as the capacity is 40–50 passengers and the object short

to medium-range operation. The Rolls-Royce RB.163 or the SNECMA turbofan built under licence from Pratt & Whitney seems the likely choice of engine.

In any case, seeing all the possibilities offered by the *Caravelle*, Sud Aviation need have no worry about its immediate future, even if it is not very simple to sell the first 220 aircraft necessary to cover the development costs. And what then? It is of course well known that Sud Aviation has for some time been working with Dassault on a supersonic civil aircraft, and it would not be unreasonable to expect some disclosures on the occasion of the Paris Salon.

From the Paris to the Rallye

The cloudless sky and the snow-covered Pyrenees are much in evidence on arrival at Ossun-Louey, and the untroubled mood at the Morane-Saulnier facility matches the scenery. Although the 4-seat *Paris* jet tourist aircraft is still in full production and is even being further developed (the *Paris II* and *III* with two Turboméca *Marboré VI* engines), this enterprise is already preoccupied with the *Rallye* sports model. Up to March 20th, 1961, Morane-Saulnier had accepted orders for 270 *Rallye-Clubs* and *Super-Rallyes*, including export contracts for 163 aircraft—this before production had started at all.

The *Rallye* family has at present three members: the *Rallye-Club* with a continental C90 90 h.p. engine, the same with a Continental O200-A 100 h.p. engine and the *Super-Rallye* with a Continental O320-A 145 h.p. engine. For the last of the three, the manufacturer is counting on good outlets in the USA. It is also of interest that, to date, orders for the *Super-Rallye* (52 percent) and for the 100 h.p. *Rallye-Club* (45 percent) have kept roughly equal, with the 90 h.p. model a very poor third (only 3 percent).

What is the secret of this success? It lies mainly in the rigorous reduction of the number of man-hours required for production. Wherever possible, spot welding is employed; riveting is used only for vital parts, such as wing spars and wing-fuselage joints. Thanks to sophisticated installations, which involve wide use of plastics, the hope at Ossun-Louey is that it will be possible to complete the assembly stage in under 300 man-hours. The company is at present building several of its own paint shops, and series production shops are also available, although they require re-equipping.

Bordes sends gas turbines all over the world

Although they are not unaccustomed to success, Joseph Szydlowski, Chairman and General Manager of Turboméca, and his staff must surely feel considerable satisfaction at seeing their engines in about a dozen of the prototypes displayed in Paris. From the days of the early pioneers to the supersonic age, nothing has changed. In the first place there was the engine—and then came the aircraft constructor and built his airframe round it. And if Turboméca has created a completely new class of engines, it has at the same time paved the way for new categories of aircraft. There were the *Palouste* for the *Djinn*, the *Artouste* for the *Alouette*, later came the *Marboré* for the *Magister*, and now today the *Bastan*, *Turmo* and *Astazou* open up the long sought-after short-range market to the turboprop, the more so as Turboméca's propeller turbines are a match for piston engines of the same rating in respect of specific consumption.

The second prototype of the Morane-Saulnier MS.880 *Rallye-Club* four-seat touring aircraft has been undergoing flight tests since February 10th. The MS.880 will be offered with a 90 h.p. Continental C90-14F engine or a 100 h.p. Continental O200-A. Powered by a 145 h.p. Continental O320-A, the aircraft will bear the designation MS. 885 *Super Rallye*. By March 24th, 1961, Morane-Saulnier had received firm orders for 270 of the aircraft, 163 of which were from abroad.

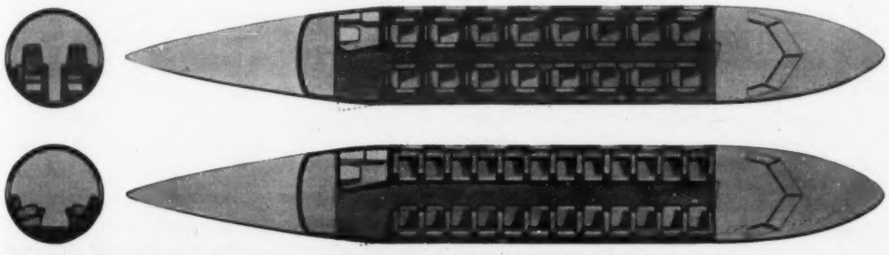
In a tour of the works, which at present give employment to some 1,500 people, even the non-technically-minded would be convinced that not only research and development (there are no less than 40 test rigs), but also planning and organization, are the keynotes here; in a word, rationalization. Many of the machine tools are semi- or fully automatic, and moreover were partly developed within Turboméca itself.

Fixed-wing aircraft, helicopters, and missiles equipped with Turboméca engines are in service in more than 25 countries, and in four of these, namely U.K., Spain, USA and Yugoslavia, there are licence producers. Overhaul rights outside France have been obtained by nine firms in as many countries.

The development of a small by-pass engine has not yet been officially confirmed by the management, as it is business policy in Bordes to publicize only engines which are ready for series production. In the meantime, however, it has been publizhed in another quarter that the new Swedish SAAB 105 executive aircraft is to be equipped with Turboméca by-bass jet engines.

The Alizé for India

On the Atlantic coast, at Biarritz, the *Alizé* anti-submarine aircraft is in production. Breguet having completed deliveries to the French naval air arm of over 60 of these aircraft (out of a total order of 75), the Indian Chargé d'Affaires took

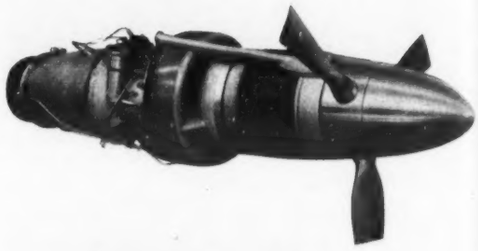


Seating arrangements in the Potez 840. Above, for 16 passengers; below, for 24 passengers.

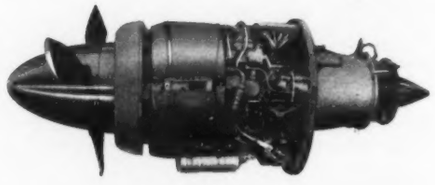
Among the aircraft which will be presented to the general public for the first time at the Paris Show is the Potez 840 short-haul airliner. Powered by four Turboméca *Astazou II* propeller turbines, each with a maximum rating of 530 h.p., the Potez 840 has a cruising speed of over 300 m.p.h. The luxury version can transport 16 passengers over 930 miles, the tourist version 24 passengers over 620 miles.

Turboméca's plant at Bordes, near Pau, at the foot of the Pyrenees, develops and produces turbines of low to medium power. Above and below, workshops; right, five of Turboméca's more recent engines.

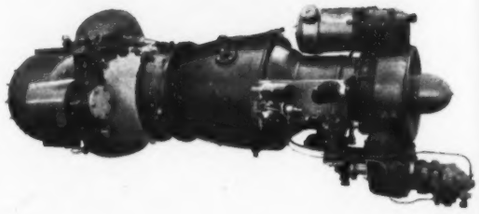
Marboré VI jet engine; max. thrust 1,056 lb; installed in Potez-Air Fouga CM. 209 *Magister*, Potez-Heinkel CM. 191 and Morane-Saulnier MS. 260 *Paris II*.



Astazou II propeller turbine; take-off rating 550 s. h. p.; max. continuous rating (20,000 ft, 310 m.p.h.) 365 s.h.p., or 377 e.h.p.; fuel consumption in the latter case 0.51 lb/e.h.p.; installed in Potez 840 Dornier Do 27 and SFERMA/Beech *Marquis*.



Bastan IV propeller turbine rated at 930 s.h.p. for take-off (corresponds to 1,000 e.h.p.) at 33,500 r.p.m.; weight equipped, complete with accessories, dry: 671 lb. Type certification was granted on January 20th.



From 750 h.p. in 1958, the power of the *Turmo III* shaft turbine has been raised to 1,200 h.p. (*Turmo IIIC* illustrated in picture). A power of 1,500 h.p. is expected by 1962.

delivery early this year of the first of the 12 aircraft destined for the aircraft carrier *Vikrant*. Since only a few nations possess aircraft carriers, the market now seems fairly saturated, particularly as Great Britain and the USA are, so to speak, "self-sufficient" in this respect. Brazil has been interested, but so far not beyond the stage of visits and non-committal conversations. In any case, as the *Alizé* assembly line draws to an end, Breguet should be able to follow on with the assembly of the *Atlantic*, 24 of which are destined for the French forces alone.

At Anglet, Breguet is working partly for the account of other companies, fitting out the rear fuselage of the *Caravelle* and nose portion of the *Mirage IIIC*, and installing the CSF *Cyrano* fire control radar. Gliders should also not be overlooked. Early in January, the French authorities selected the Breguet 906 *Choucas* 2-seat glider, derived from the *Fauvette*, as the standard type for advanced training at national flying clubs; and in March this year the *Fauvette* received USA type certification.

In Bordeaux-Mérignac, at Dassault

Of the 547 fixed-wing aircraft provided for under the French Government's programme law, no less than 370 fall to Générale Aéronautique Marcel Dassault. In addition to this Government contract governed by the programme law, Dassault can count on export orders: the Swiss cabinet and defence committee have, as is well known, recommended the provision of 100 *Mirage IIICs*, although this decision still requires parliamentary approval, and Australia decided to have 30 aircraft, which, however, it desires to produce itself under licence.

A short while ago series assembly of the *Mirage IIIC* started at Mérignac and assembly of the *Etendard IVM* is following parallel lines. Since carrier-borne naval aircraft make special demands in the way of surface protection, more space is now being built to take the new installations.

SFERMA created a department for the overhaul of Turboméca gas turbines in 1958. Picture shows the safety cage where *Artouste* shaft turbines are tested with rotors.

There have, in the course of time, been many offshoots of the 10- to 12-seat MD 415 *Communauté*. The *Spirale*, which flew for the first time in April 1960, is a military version with two Turboméca *Bastan* turboprops, each with 930 h.p. take-off rating. There is also an aussault transport with stern loading ramp, which can transport one jeep or 14 soldiers in battle order at 312 m.p.h. for a range of 1,540 miles, but only a mock-up of the fuselage has so far been built.

Under the designation *Communauté A1*, Dassault, working in conjunction with Sud Aviation, has built a short-range civil aircraft for 21—24 passengers. The plane is to be powered by 2 Turboméca *Bastan IV* turboprops (930 s.h.p.) driving three-blade Ratier-Figeac constant-speed propellers of 9 ft diameter. A mock-up of this aircraft will be on exhibition at the forthcoming Paris Air Show. At the same time, in its executive version, the *Communauté A1* offers room for 4—8 passengers. Maximum speed is 303 m.p.h. at 19,100 ft; range where carrying 1,700 lb payload (with 17 mile head wind and normal fuel reserve) is 1,810 mi; and direct operational costs with 21 passengers on most economical (375 mi) runs amount to 3.6 U.S. cents per mile.

The Sud-Dassault *Spirale* paved the way for the first time for cooperation between the "big two" of the French aviation industry, cooperation which, in the case of the new joint project for a

supersonic civil aircraft, will bear rich fruits. Dassault is contributing to the partnership long experience of supersonic flight, whilst Sud Aviation is thoroughly conversant with the demands of traffic operators.

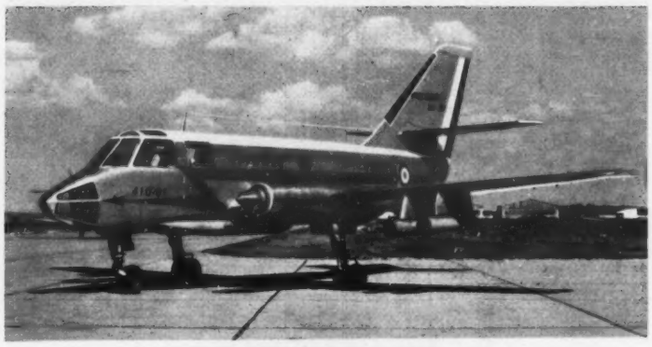
The Years Ahead

Many competitors will be tempted into the rewarding markets offered by three categories of aircraft, two military and one civil.

● *The supersonic combat aircraft with VTOL characteristics.* In the absence of their own engines, French projects rely on British products; Sud Aviation and GAMD are sticking to the Rolls-Royce answer for the VTOL *Mirage*, whereas Breguet and Nord have more liking for the BS.53. As already published, SNECMA is cooperating with Turboméca on the development of a lift jet engine. Together with Nord, SNECMA is studying the secondary air flow reheating in the aft-fan engine.

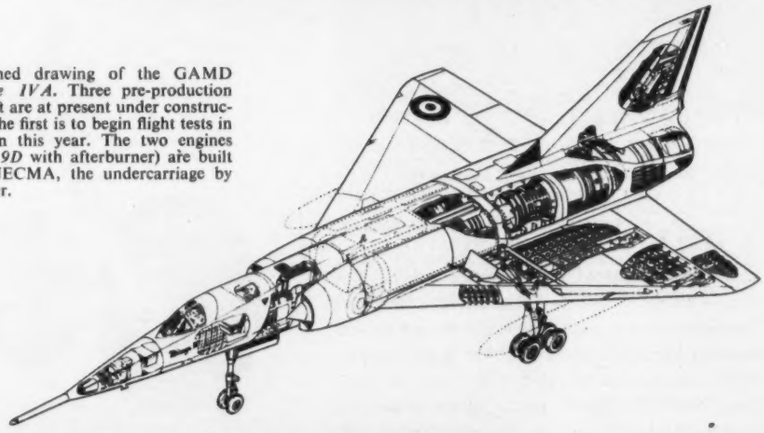
● *VTOL transport* Whilst Breguet is in favour of S/VTOL, Nord desires to verticalize its *Noratlas* by lift jet engines under the wings. As regards stabilization, SNECMA's experience with the *Atar Volant* could well be of value.

● *Supersonic civil aircraft.* It is an open secret that Sud Aviation is working jointly with GAMD on a civil aircraft for speeds equivalent to Mach 2.2. In an interview last February, Pierre Satre, Technical Director of Sud Aviation, gave these data: take-off weight of the order of 60–70 tons, four engines, 70–80 passenger capacity. As emerges from later reports, the range should be 2,000 miles. At the same time, SNECMA is at work on a corresponding engine, designation M-35, which is a development of the Pratt & Whitney J58. Nord is putting forward a design for a transatlantic aircraft, which would be able to transport 125 passengers at a cruising speed equivalent to Mach 3, for which the engine is said to be a combination of an aft-fan turbojet with a ramjet. The *Griffon* is godfather to this concept and will be used by Nord, after the airframe has been modified, to penetrate to a higher Mach range—always provided that the necessary financial support is forthcoming. ←←

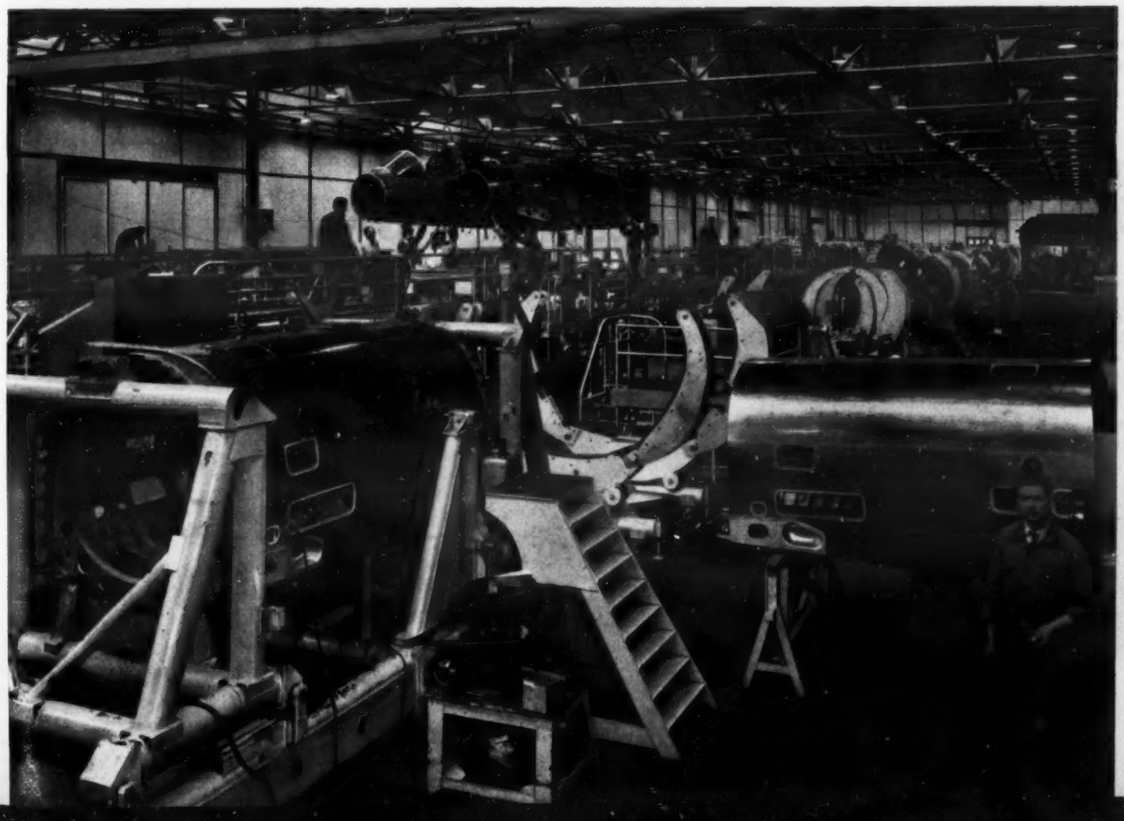


The Dassault-Sud *Spirale* military multi-purpose aircraft is suitable for reconnaissance, ground support in local conflicts, training and troop transport. It is a direct derivative of the MD. 215 *Communauté*. Powerplant: two Turboméca *Bastan* propeller turbines.

Last-minute preparations for the test flight of a GAMD *Mirage IIIC* at Bordeaux–Mérignac.

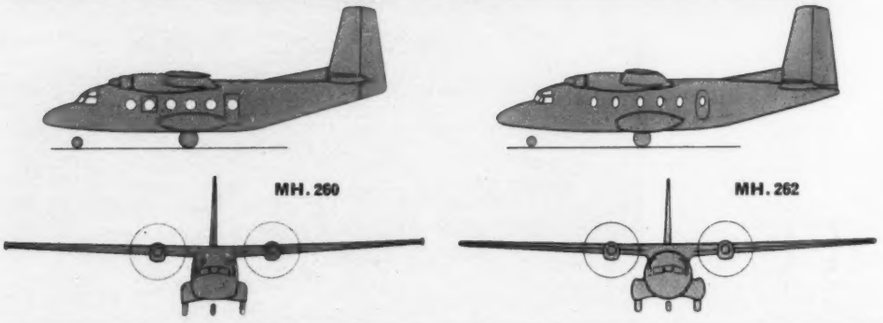


Sectioned drawing of the GAMD *Mirage IVA*. Three pre-production aircraft are at present under construction; the first is to begin flight tests in autumn this year. The two engines (*Atar 9D* with afterburner) are built by SNECMA, the undercarriage by Messier.



***Mirage IIIC* and *IIIB* fuselages are assembled and equipped at Générale Aéronautique Marcel Dassault's Argenteuil works.**

Prototype of the Max Holste MH.260 *Super Broussard*, which has been undergoing test flights since July 29th, 1960. Nord-Aviation will be responsible for production. A pressure-cabin version, the MH.262, has recently been announced.



Nord-Max Holste Super Broussard

	MH.260	MH.262
Wing span	71.7 ft	72.37 ft
Length	58.1 ft	62.44 ft
Height	23.46 ft	23.1 ft
Useful cabin volume	1,236 cu.ft.	1,095 cu.ft.
Engines	Two Turboméca *Bastan IV* propeller turbines, each rated at 1,000 e.h.p. for take-off	
Propeller	Ratier-Figeac three-blade variable pitch propeller with diameter of 9.57 ft	
Undercarriage	ERAM tricycle undercarriage, tyre pressure 45 p.s.i. (nose-wheel) and 48 p.s.i. (main wheels)	
Weight equipped	11,915 lb	12,870 lb
Maximum gross weight	21,670 lb	
Payload	8,545 lb	8,690 lb
Number of passengers	up to 26	
Economic cruising speed	213 kt (at 10,000 ft)	216 kt (at 13,200 ft)
Max. range with fuel reserves	620 n.m.	610 n.m.
Take-off distance over 35 ft	1,617 ft	
Landing distance over 35 ft	1,584 ft	

But in the military sphere Dassault has planned for the future. The prototype of a *Balzac* VTOL combat aircraft with Rolls-Royce lift jet engines is expected to lead to a Mach 2 VTOL combat aircraft, which NATO will be requiring in the second half of the sixties.

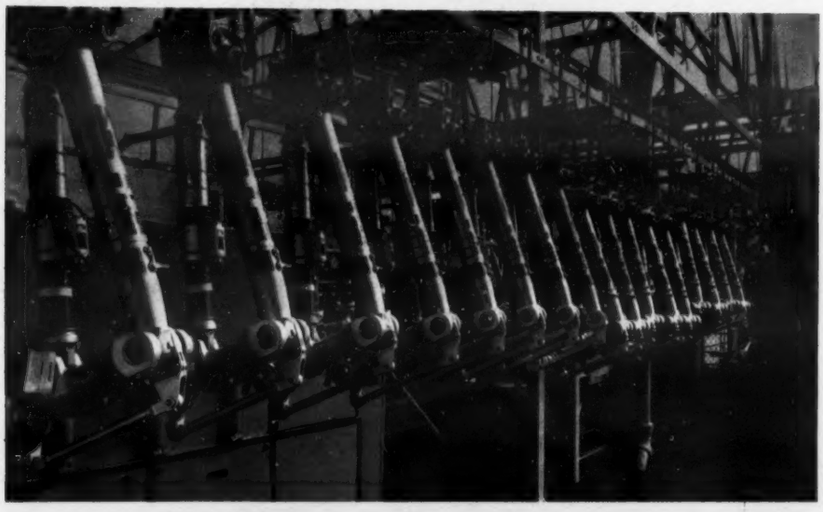
A call on SFERMA

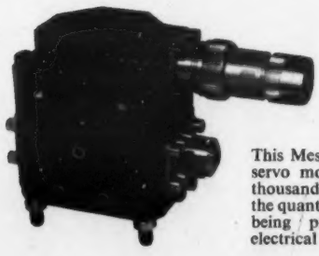
In leaving Dassault to call on SFERMA nearby, one is struck by the vast difference between a typical series construction factory and a repair yard for "all sorts." On September 1st 1959, when it was founded as a branch of, as it then was, SNCASO, the original object of SFERMA was aircraft maintenance and repair. With increasing tooling and growing staff, this go-ahead company was gradually able to tackle more ambitious operations, with the design office and business connections of the parent company, Sud Aviation, always behind it. Such operations include engine overhaul and maintenance, the "rejuvenation" of aircraft by installation of more powerful engines, and, lastly, conversion of piston engine aircraft to turboprop systems. SFERMA certainly became better known internationally through the first conversion prototype than through the repair of 1,400 aircraft of 60 different types.

For aircraft which must operate from unprepared sites, Messier has developed the *Jockey* undercarriage, which is extremely simple in construction and hence requires minimum maintenance. A *Jockey* undercarriage is being installed in the Breguet 941.

Whether it is a matter of more powerful engines or of turboprops, the units in question are exclusively by Turboméca, which, since 1959, has also been financially interested in the concern and whose representative on the Board is Chairman Szydlowski. Out of a first contact with Beech Aircraft Corporation in 1955, there quickly developed a close cooperation which, in October 1960, finally led to a long term agreement under which SFERMA has acquired the rights to convert Beech aircraft and to sell them in Europe, Africa (less Egypt), Israel, Iran and Turkey, whilst Beech reserves the rest of the world for itself. In the context of this agreement, SFERMA is now constructing a series of PD-146 *Turbo-Travel Airs* (with 2 Turboméca 180 h.p. 440 h.p. *Astazous* instead of 2 Lycoming 180 h.p. O-360s). Meanwhile Beech has brought out a further development, the *Baron*, which is being "promoted" by SFERMA to the *Marquis*.

Assembly line for the Fiat G.91 main undercarriage at the Messier Bidos works.





This Messier electro-hydraulic servo motor responds within thousandths of a second, with the quantity of power delivered being proportional to the electrical input signal.

Landing Gear Specialists

These are the words which Messier has been using to describe its function since the formation of the company. Their justification lies in the following (incomplete) list of aircraft types produced in considerable quantities which are equipped with Messier landing gear: the Dassault *Ouragan, Mystère* and *Mirage III*, the Nord *Noratlas*, the Fouga *Magister*, the Fiat G.91 and the SE. 3130 *Alouette II*. The proudest new development is the *Jockey* landing gear, as installed in the Breguet 941 and, in modified form, in the *Transall*. A visit to Montrouge, where Messier produces pre-series and prototypes, gives a good idea of the effort put into research and development alone.

If the STOL aircraft, which must in general also be designed for operation from unprepared country, in many respects complicates the landing gear builder's problems, the design of landing gear for the VTOL does not for its part relieve him of all headaches. In the case of the VTOL, the heat and corrosive action of the exhaust gas jet on the one hand, and the uncertainty of the landing direction on the other, create entirely new conditions, although of course the ever-increasing demands made by level starters on the brakes do not have to be taken into consideration.

It goes without saying that Messier also produces hydraulic devices of various types, indeed the word hydraulic runs like a conspicuous thread through the production programme of every landing gear producer. For example, pumps for outputs of 8, 9, 13 and 22 gallons per minute are in regular production. A special department of Messier cooperates with CSF in the production of aerial mechanisms for aircraft radar. •

The Future Hangs on Research

While the French aircraft industry is carrying on applied research with its new developments, basic research is largely in the hands of the Office National d'Etudes et de Recherches Aéronautiques (ONERA). Although the organization is financed entirely out of State funds, scientists and test installations are available to private industry. With about 1,900 employees—500 of whom are scientists—ONERA has five divisions: aerodynamics, powerplants, structures, materials and applied physics. As it is impossible, for reasons of space, to describe the activities of these divisions in greater detail, a few of the more recent activities of ONERA should be mentioned: flow research at high Mach numbers, aerodynamic heating of bodies, plasma and ion propulsion, fatigue phenomena, heat-resistant materials, data recording and telemetry.

Among the most impressive of ONERA's installations are its wind tunnels. At Modane-Avrieux, near the Italian frontier, a large experimental facility has been built, consisting of the S1-MA closed tunnel (Mach 0.98 to 1.03; diameter of test section 26 ft; power 110,000 h.p.), the S2-MA closed tunnel (test section measures 6.1 × 5.77 ft; Mach number range 0.9 to 1.4 or 1.6 to 3.2) and the S3-MA supersonic tunnel (test section measures 2.64 × 2.47 ft; up to Mach 6.5; blow-down time 30 seconds). At Chalais-Meudon the old, "slow" tunnel (132 to 165 ft/sec) has been given a new lease of life with the development of STOL and VTOL aircraft. Two smaller supersonic tunnels, the R1 and R2, serve for research in the Mach 3 to 5 and Mach 5 to 7 speed ranges. The latest acquisition is the hypersonic tunnel (cf. picture) at Fontenay-sous-Bois, in which the physical conditions encountered on re-entry into the atmosphere can be simulated for the duration of a few milliseconds (flow speeds of up to Mach 20). Power (20,000 amp at 2,000 to 3,000 volts for a duration of 0.06 sec) is supplied from the public mains. With a view to the planned extension of the present operating range, the electrical installation has been designed for a power of 400,000 kVA.

The *Antarès* four-stage solid-propellant rocket, which can obtain 200,000 data on a single flight, also serves to investigate the re-entry process. A further development, the *Bérénice*, which can transport a 132 lb scientific payload to an altitude of 600 miles, will reach operational status this year.

Although such research is costly, it is urgently needed, as it provides the foundation for tomorrow's developments and ensures the continued existence of the French aircraft industry.

In the Do 27, SFERMA has replaced the 275 h.p. Lycoming GO-480-B1A6 piston engine by a Turboméca *Astazou II* rated at 530 s.h.p. for take-off. The new turboprop version, which began flight tests on March 6th, has already given an impressive performance (figures in parentheses refer to the "original" Do 27): maximum speed 186 m.p.h. (155 m.p.h.); rate of climb 1,575 ft/min (885 ft/min); service ceiling over 26,250 ft (14,760 ft).

Founded in 1949 as a subsidiary of SNCASO for the maintenance and repair of aircraft, SFERMA has for more than two years been converting piston-engine aircraft to propeller-turbine operation. Picture shows the SFERMA/Beechcraft PD.146 *Turbo-Travel Air* four-seat touring aircraft, powered by two Turboméca *Astazous* rated at 440 s.h.p. each for take-off. A Beech *Baron* converted by SFERMA to two *Astazou IIs* has been further ennobled to the rank of *Marquis* and will be demonstrated in flight at the Paris Show.

The tour is over. Much more could have been said, and many a firm which makes a vital contribution to aviation has had to be left out; the equipment and electronic industries have come off badly.

France's aviation industry need not fear comparison with other countries, and the export orders of the last few years speak for themselves. In many respects, France has done pioneer work; in low-power shaft turbines, jet engines, and turboprops, in medium-range jet aircraft for civil purposes, in light turbine-powered helicopters, in high-lift wing STOL aircraft and in ramjet engines.

There is, of course, still leeway to be made up, especially in those fields where, for want of liberal support from the Government, it has not been possible to start on development projects. But it will be necessary to make haste if a link is to be found with the industries of Great Britain and America, which are already opening up for themselves the markets for aft-fan and VTOL engines. And duplication of effort at home can hardly occur again if there is closer association, in one way or another, between the producers who constitute the French aeronautical industry. Such association is, in any case, probably necessary for the realization of the challenging and expensive projects to come. ←←

The American

Never before has the American aircraft industry been represented in Europe by such a large number of exhibitors and products as this year at the 24th Paris Air Show. The heightened interest of the USA in Europe is due to a number of factors.

In the last two years, NATO programmes in which American manufacturers have an important share have matured. In addition, major firms in the U.S. aircraft industry have been making increasing efforts to found subsidiaries in Europe or form associations with large European concerns. Here again, the prospects of sales to NATO have played a part, but there is also the desire to obtain a footing in one of other of the two European economic blocs.

To a certain extent, this "emigration" is conditioned by major changes in production programmes. In their own country, many of the old-established American aircraft manufacturers have been obliged to turn to the manufacture of non-aviation products, so that the possibility of continuing their aviation activities in Europe is very welcome. Moreover, the industry's new activities have provided it with experience which is extremely useful in European markets. Above all, it has been the boom in the electronic industry which has enticed such large firms as Bendix, General Precision, IBM, Lockheed, Minneapolis-Honeywell, North American and others to Europe. This is an aspect of the picture which will doubtless be reflected at the Paris Air Show.

The strengthening of the contacts between the two continents is also due to the fact that the American forces in Europe employ a large number of European equipment and servicing organizations. This will, of course, not be seen in the U.S. forces' contribution at the Paris Show, for the main aim of the American authorities is to show the decisive contribution which the USA has made to the development of international aviation and astronautics, illustrating the rapid evolution of the former by showing a model of the Wright brothers' first aircraft alongside a model of the B-70 supersonic bomber.

The U.S. Government stand will also contain exhibits relating to the thorny problems of air traffic control and the preliminary work being done on a Mach 3 airliner, models of a number of space vehicles and satellites and a survey of American developments in the field of boosters for space vehicles.

The military aircraft to be shown in the static park and in flight will reportedly include: USAF—Lockheed F-104 Starfighter and Convair F-106 *Delta Dart* fighters, Republic F-105 *Thunderchief* fighter-bomber, Northrop T-38 *Talon* and North American T-39 *Sabreliner* trainers, Lockheed *JetStar* multi-purpose aircraft, Lockheed C-130 *Hercules* and Douglas C-133 *Cargomaster* turbine-powered freight aircraft, plus various helicopters and ground support equipment; U.S. Navy—Chance Vought F8U-2 *Crusader* and McDonnell F4H *Phantom II* fighters, the A3J *Vigilante* carrier-borne supersonic bomber and other combat and reconnaissance aircraft. The list of American exhibitors is so long that the following pages can give only brief excerpts from the programmes of the main firms.

The Republic F-105D *Thunderchief* all-weather fighter-bomber is replacing the *Super Sabres* of the USAF Tactical Air Command. Powered with a Pratt & Whitney J75P jet engine of over 24,000 lb thrust with reheat, the *Thunderchief* has a maximum speed of Mach 2.15. The Netherlands firm of Fokker will carry out maintenance and overhaul work for F-105 units stationed in Europe.

The participation of **Aerojet-General Corporation,** Azusa, Calif., in Paris will be limited to exhibiting its newest types of jet-assisted take-off rockets, as are in series production for use in military and civil aircraft.

The **AiResearch Manufacturing Company,** Los Angeles, Calif., which is a subsidiary of the Garrett Corp., will be showing a cross section of its production programme, including environmental control systems for commercial and military aircraft, auxiliary power units for missiles, cryogenic valves and controls, also the life-support system for the *Mercury* cabin and a sectional model of the Boeing 727 (in the colours of Eastern Airlines), with cutaway to show the pressurization and air conditioning equipment furnished by AiResearch.

Sharing a stand with several members of the equipment industry, **Avco Corporation** will be exhibiting some of the products of its Research and Advanced Development Division, Wilmington, Mass., including a pneumatic shock test machine, an acoustic noise generator, a plasma gun and various vibration testing devices.

Aviquipo, Inc., New York, N.Y., will be giving a survey of the products it distributes throughout the world, by means of photographs and descriptive matter. These include, *inter alia*, engine starting equipment by the Accessory Controls and Equipment Corporation, flexible hosing by the Aeroquip Corporation, loading and servicing equipment by Air Cargo Equipment Co., life rafts and air-sea rescue equipment by Air Cruisers (a department of Garrett Corp.), sparking plugs by the Champion Spark Plug Co., visual flight simulators by the Dalto Corporation, aircraft lighting systems by the Grimes Manufacturing Company, elastic suspension devices by the Lord Manufacturing Company, mobile AC and DC generators by the Motor Generator Company, valves by Parker Hannifin Corp., gliders by the Schweizer Aircraft Corporation, and instruments by United States Gauge. Amongst other firms represented by Aviquipo are: Air Supply International, Abex, Breeze Corporations, Coast Pro-Seal & Mfg. Company, Gould-National Batteries, Pioneer Aluminum Supply Company, Republic Manufacturing Company, and Sensenich Corporation.

Beech Aircraft Corporation, Wichita, Kans., plans to bring to Paris a complete collection of all the types of executive and touring aircraft it produces. Seriously interested persons are to be given the opportunity of convincing themselves of the flight characteristics of Beech aircraft by taking the controls themselves. Sectional models and literature will be available at the stand to illustrate the choice of cabin installations and additional equipment available; 1 : 5 scale models of all the target and reconnaissance drones produced by Beech will be on view, such as the 1025 target drone which is in use by the Army for training anti-aircraft units, the Navy's KDB-1 supersonic drone and the new KD2B-1 target drone which flies at Mach 2 and is to come into service with the U.S. Navy in 1962.

By grouping the products of its subsidiaries Bell Aerosystems Company, Bell Helicopter Company, and Hydraulic Research & Manufacturing Company, in one stand, **Bell Aerospace Corporation,** Buffalo, N.Y. will present a comprehensive picture of the activities of the group. Electro-hydraulic servo control systems, flow control transducers and hydraulic and pneu-

Industry's Bridgehead in Europe

matic valves are as much part of the exhibit as a rocket engine using liquid fluorine. Bell supplies the miniature accelerometers for the *Skybolt* strategic air-to-ground missile, the *Sergeant* artillery rocket and the *Midas* warning satellite, and is producing the *Hipernas* high performance navigation system (inertial guidance) for submarines, surface vessels, and space vehicles.

Bell also builds radar systems, air traffic beacon control systems and recovery systems for drones and ballistic missiles. An all-weather landing system ordered by the U.S.Navy is currently being developed for civil use. Apart from control jets for the X-15 and *Mercury*, Bell is producing the rocket engine for the *Agena*, the carrier vehicle for the *Discoverer* and *Midas* satellites. It goes without saying that the Bell Helicopter Company will be displaying comprehensive information about the 3-seat 47G-2A and 47-G3 *Trooper*, the 4-seat 47J-2 *Ranger* and its turbine-powered sister the HUL-1B, as well as the HU-1A *Iroquois* turbine-powered military helicopter, which last year set up seven world records; all these were developed by Bell. Two S/VTOL projects, a supersonic combat aircraft with swivelling engines and a transport with ducted propellers, will be on exhibition in model form.

Bendix Corporation, Detroit, Mich., represented by its International Division, will be displaying the products of its two dozen departments. Besides servo-motors, servo-valves and hydraulic pumps, Bendix will show fuel systems high temperature material actuators, movable nozzles for thrust vector control; equipment for data transmission and data processing, inertial platforms, air position computers and components of missile and rocket stabilization systems, operational testing equipment for missiles and carrier-rockets, power supplies for satellites (solar cell systems), will also be on display. The exhibits will further include electronically controlled antennas for satellite tracking (especially for long-range communication satellites). Lastly Bendix will stress its participation in the development of the *Advent* and *Courrier* satellites.

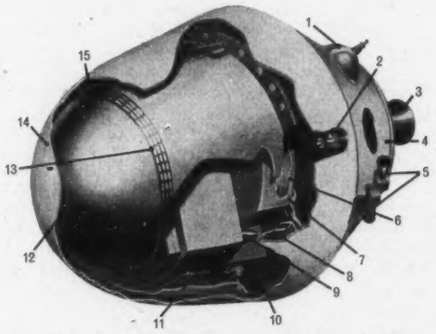
The Boeing Airplane Comp., Seattle, Washington, has decided not to take a stand but to be content with two exhibition tents on the apron.

On a joint stand with their European agents, the **Cessna Aircraft Company,** Wichita, Kansas, will be exhibiting executive aircraft of the 185 *Skywagon*, 310F and 210 types. It is expected that all Cessna's new types, with the exception of the *Skyhook* helicopter, will take part in the air display. The reason for the absence of the *Skyhook* is that the Paris Air Show coincides with a demonstration tour which the prototype is making in the USA, whilst first production models are not expected to leave the factory until the end of June.

On the joint stand of various firms in the equipment industry, which we have already referred to, the **Chadwick-Helmuth Company,** Monrovia, California, is exhibiting its vibration investigation equipment, which is well known under the designation *Slip-Sync System*, whilst the **Columbia Research and Development Corporation,** Columbus, Ohio, is showing accelerometers and frequency analyzers and **Conrad Inc.,** Holland, Michigan, a photographic mural to illustrate its temperature and altitude simulation chambers.

Represented at the U.S. Air Force air display by some F-102 *Delta Daggers* and probably by a supersonic B-58 *Hustler* bomber, the General Dynamics Corporation's **Convair Division** of San Diego, Calif., is taking a stand at which, in all probability, the emphasis will be mainly on its developments in the civil field.

Among the exhibits of the **Curtiss-Wright Corporation** of Woodbridge, N.J., the model of



The General Electric Company Missile and Space Vehicle Department developed the *Discoverer* re-entry capsule which on August 11th, 1960 was the first to return safe and sound to earth after a number of orbits, being recovered in the Pacific. 1 – cold gas storage tank; 2 – explosive bolt; 3 – retro-rocket; 4 – thrust cone; 5 – stabilization jets; 6 – recovery parachute and chaff; 7 – parachute cover; 8 – explosive pistons; 9 – flashing light; 10 – afterbody cover; 11 – instrumentation package; 12 – radio beacon (inside); 13 – dye markers; 14 – ablating re-entry shield; 15 – recoverable capsule.

the type 200 6-seat VTOL executive aircraft will undoubtedly attract the attention of visitors. Three prototypes of this aircraft, with four swivelling propellers, are currently under construction. Curtiss-Wright is also showing a C-band radar, radar maintenance training equipment, a noise suppression device, fibreglass propeller blades, the *Swench* manual impact wrench, and a mechanical actuation control system.

The **Douglas Aircraft Company,** Santa Monica, Calif., is building a model of the *Thor* carrier rocket into the centre of its stand; the rocket will be crowned by a shining silver ball, representing the *Echo I* balloon satellite. Pictures and charts will give information about the use of *Thor* in space research. The rest of the stand is divided between the DC-8, the *Speedfreighter* DC-7F and the Sud-Aviation *Caravelle*; for the latter, as is well known, Douglas has obtained distribution and production rights. Douglas will also announce details of the future nuclear-powered aircraft project. In the display, Douglas will be represented by the *Thor* medium-range rocket, the *Nike-Zeus* ground-to-air missile, and by the *Cargomaster* C-133, the *Skywarrior* A3D and the *Skyhawk* A4D.

On the stand of **General Electric Company,** New York, N.Y., the lion's share of the exhibit consists of sectional models and mock-ups of engines. The pièce de résistance will be a sectional model of the J79 jet engine, with afterburner, with which aircraft such as the Convair B-58, Lockheed F-104, McDonnell F4H and North American A3J have won 18 world speed or altitude records. Also shown in full-size will be the CJ-805-23 turbojet (including thrust reverser and noise suppressor), the J85-5, CJ 610 and CF 700; and T58 and T64 shaft engines. The 240 turbo engine, derived from the CJ-805 aft fan engine, is offered as a power unit for hydrofoil vessels. A model of a vessel of this type will be on view. General Electric's lift-fan principle will be displayed in the model of a VTOL aircraft. Amongst other exhibits will be models of an afterburner and an aft-fan, the re-entry capsule of a *Discoverer* satellite, flow meters, gyro platforms, a constant speed drive unit, transistorized radio equipment and some other electronic products.

The **Grumman Aircraft Engineering Corporation,** Long Island, N.Y., is participating in the exhibition with the following aircraft: The G-159 *Gulfstream*, the WF-2 *Tracer*, the S2F-1 *Tracker*, the AO-1 *Mohawk* and the SA-16B *Albatross* (or in its UF-2G coastguard version). On the Grumman stand there will be emphasis on all these types and on a hydrofoil ship, which is under construction for the Italian navy. In cooperation with NASA, Grumman is developing the *Orbiting Astronomical Observatory*, a space vehicle of which a model is to be demonstrated in full detail on Space Day (May 31st). The *Gulfstream* will take part in the air display on 27th May (Sport and Light Aircraft Day), the *Albatross* on 29th May (Air and Space Medicine Day), the *Tracer* on 30th May (Electronics Day) and the

The Lockheed F-104 *Starfighter* multi-purpose single-seat combat aircraft has been chosen by the NATO States of Belgium, Federal Germany, Italy and the Netherlands as the main weapon system for their Air Force tactical units. A joint programme covers the licence production of 949 of the aircraft, with a further 126 being delivered by Lockheed.

Mohawk on 1st June (Helicopter and S/VTOL Day).

The **Hiller Aircraft Corporation,** Palo Alto, Calif., is exhibiting a 4-seat 12E-4 helicopter as well as the X-18 VTOL. This trial model has a tilting wing and two Allison T40 turboprops, and has been undergoing flight trials since November 24th 1959. Pitch stabilization in hovering flight is achieved by a vertical exhaust jet from a Westinghouse J34 turbojet at the stern.

The **Kollsman Instrument Corporation,** Elmhurst, N.Y., is using the Paris Air Show to give full publicity to their new manufacturing plant at Munich in West Germany, styled Kollsman Luftfahrt-Instrumente GmbH, where altimeters, airspeed indicators and cabin altimeters for the F-104G and G-91 programme are in current production. In the near future Kollsman will be considerably expanding the production programme of their German plant. Other products to be displayed in Paris include some of the company's flight instruments, such as rate of climb indicators and periscopic sextants, as well as a cabin pressurization system and both commercial and military air data systems.

The stand of **Lear Inc.,** Santa Monica, Calif., which is being organized by Lear International S.A., Geneva, will be displaying a wide selection from their manufacturing programme. In the forefront of the exhibits will be the L-5B LIFE-System (Lear Integrated Flight Equipment System), as installed in the F-27 Fokker Friendship and Potez 840 civil aircraft. Amongst other gyro equipment on show will be a LIFE simulator, a pitch damper for the Fiat G-91, two gyro reference systems, a subminiature ratio gyroscope, a cutaway model of a subminiature rate gyroscope, and a hot gas high pressure driven gyroscope (type 1090) for missiles. Lear is also presenting the ADF-102 automatic direction finder, electromechanical and hydraulic linear and rotary actuators, the hydraulic power unit for the *Discoverer* satellite, hydraulic pumps, a remote controlled trimmer system for gas turbine controls (as used in the DC-8, the Boeing 707 and others), a heatless, reactivating dehydrator and mock-ups of various tape instruments.

The **Lockheed Aircraft Corporation,** Burbank, Calif., has divided its large stand into twelve sections in order to give a comprehensive presentation of its activities. An illuminated globe will draw attention to each country where the F-104 is produced, and there will be an animated display showing comparative transatlantic timings for piston engine, present jet, and supersonic jet aircraft. One section of the stand is reserved for the C-130 *Hercules* and shows its versatility as a military transport, another features models and descriptions of four Lockheed commercial aircraft. Yet another section shows anti-submarine warfare and seaborne systems. The centre of the Lockheed stand will be occupied by a model of the *Polaris*, which should serve to draw the visitors' attention to the strategic submarine-based ICBM system. Lockheed's contribution to air traffic control is featured in another section of their exhibit, and at the far end of the display will be a model of outer space, with wires depicting the orbits covered by the *Agena*-launched satellites *Discoverer* and *Midas*. Lockheed aircraft are represented in the static display as well as in both air displays; they are, however, featured not by the manufacturer but as part of the USAF's contribution.

The most important exhibit of the **Martin Company,** Denver, Colorado, is the half-scale model of a *Pershing* surface-to-surface missile, which is being shown with its launching platform (the model is to some extent operable and can be raised and lowered from the launcher). Martin will also display a sectional model of the *Bullpup* missile, and a sandtable model of the PM3A nuclear plant, as installed at McMerdo Sound in the Antarctic. There will also be models and charts to illustrate the participation of this concern in the *Dyna-Soar, Apollo* and MSOL (manned space orbital laboratory) programmes.

The six divisions of **North American Aviation,** Los Angeles, Calif., will all be represented in the great hall at Le Bourget. The Los Angeles Division will be bringing the T39 *Sabreliner* trainer to Europe for the Salon, and this aircraft is afterwards to be shown in Germany, Holland, Belgium, Great Britain, Italy and Spain. It will also feature the B-70 *Valkyrie* Mach 3 bomber, from which North American hopes to gain experience for a supersonic civil aircraft. The Rocketdyne Division will show models of the rocket engines for the *Thor, Atlas* and *Saturn,* as well as the F-1 mammoth engine, and will feature information on the part it is playing in the *Kiwi* programme to develop a nuclear rocket engine. The Columbus Division will exhibit the A3J *Vigilante* and a model of the U.S. Army's *Roadrunner* target missile. Autonetics' exhibits will include the NASARR weapon guidance system, the BACE basic automatic checkout equipment, the *Verdon* digital computer, and the NADAR 8 airborne recorder equipment. Atomics International will be presenting its radiation fuel gauges, used to measure fuel in aircraft tanks. Finally, the Space and Information Systems Division will give a general picture of its activities.

Chief attraction at the stand of the **Northrop Corporation,** Beverly Hills, Calif., is the T-38 *Talon* supersonic trainer, the latest addition to the USAF's aircraft fleet. As reported at time of going to press, one *Talon* has been in Western Germany since mid-April, where it is being demonstrated to representatives of the German air force. Northrop is also exhibiting the *Datico* automatic missile checkout equipment, as used in the *Polaris*, the landing system for the *Mercury* capsule, and the Q-ball for the nosedome of the X-15. There will be an extensive display of models and diagrams of laminar flow control. Northrop, who produce all the ground handling equipment for the *Hawk* anti-aircraft weapons system, will be cooperating in this feature of the USAF air display.

Pacair Inc., Burbank, Calif., is providing colour photos and arranging short narratives in English, French and German, to give visitors full information about its activities. Pacair is concerned with the overhaul and repair of aircraft, engines, and equipment, produces spares, and possesses distributor and sales rights for flight support equipment.

In conjunction with their export agents, Jonas Aircraft & Arms Company, and with Vigors Aviation Ltd., **Piper Aircraft Corporation,** Lock Haven, Pa., will display the *Aztec, Apache, Comanche 180, Comanche 250, Cherokee, Colt, Super Cub* and *Pawnee*—in both the static and air displays. This is the first time the *Cherokee* has been put on show in Europe, and the same is true of the Piper *Altimatic Pilot* (automatic pilot equipment), which permits heading and altitude to be preselected.

The **Radio Corporation of America,** (RCA), New York, N.Y., will be exhibiting, amongst other items, two airborne radars, the AVQ-10 and AVQ-60C. The *Tiros* weather satellites, developed and equipped by RCA, will be featured to illustrate RCA's participation in space programmes.

Likewise, the **Republic Aviation Corporation,** Long Island, N.Y., is devoting a substantial part of its stand to the space research theme. The mock-up of a plasma jet rocket and model of a manned space vehicle illustrate how ambitious are the projects of Republic's new laboratory, which is about to be inaugurated as we go to press. At the same time, Republic is presenting its F-105D *Thunderchief* all-weather fighter bomber to the general public for the first time. There will be films to show the versatility and efficiency of this weapons system, and the aircraft itself will be shown in the air as part of the USAF's display. This will be a subject of considerable topical interest, since, when the Paris Air Show takes place, the first *Thunderchiefs* will have just been delivered to the Tactical Air Command's European formations—36 Fighter Squadron at Bitzburg and 49 Fighter Squadron at Spangdahlen, both in Western Germany. Whether or not Republic will be publicly exhibiting VTOL projects at Paris is not known at time of going to press.

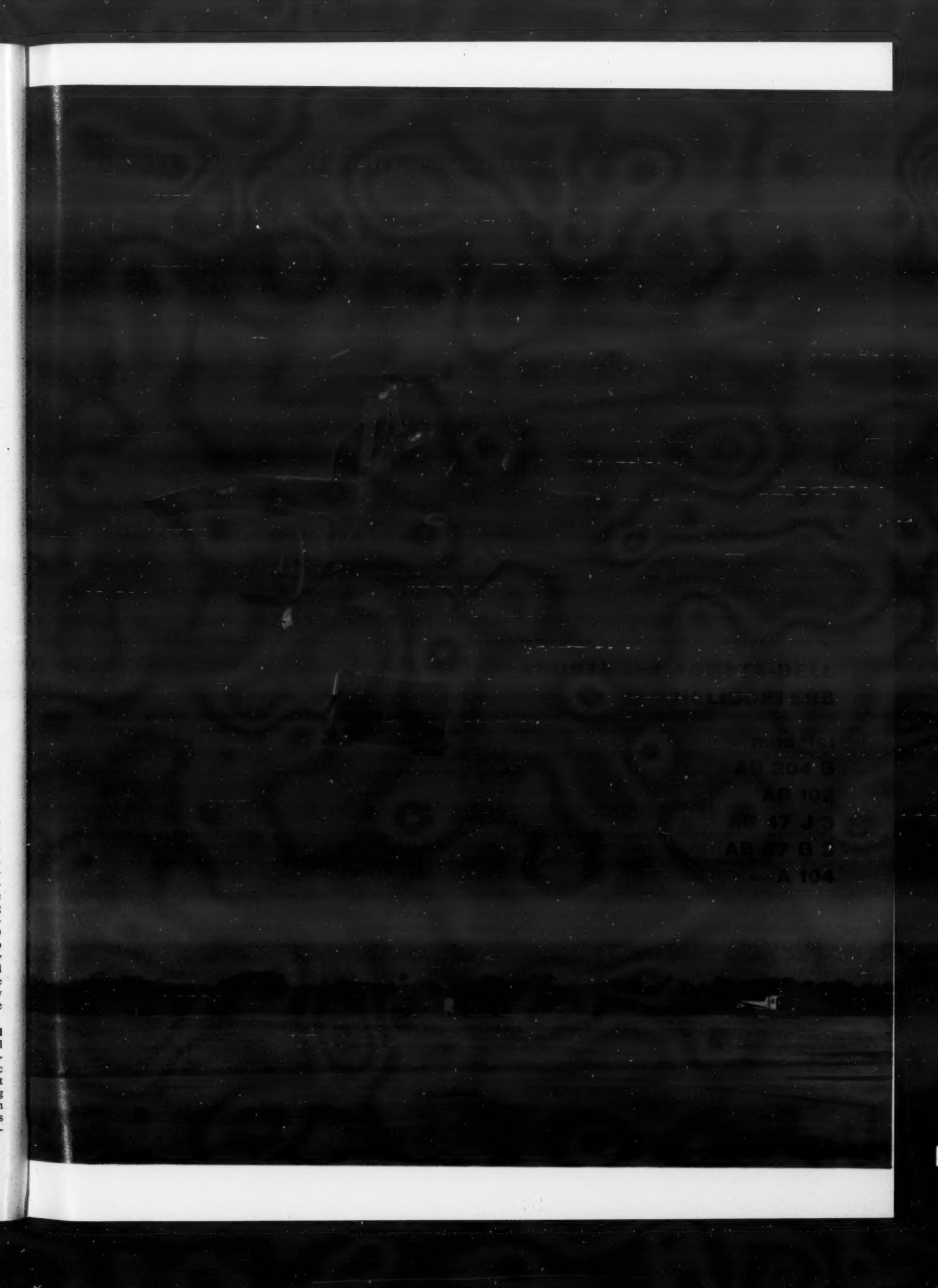
The **Ryan Aeronautical Company,** San Diego, Calif., will be exhibiting a series of navigation aids in addition to various models of the *Firebee* jet-powered target drones. Of particular interest are the continuous-wave doppler navigators, for both helicopter and fixed wing aircraft, and the AN/APN-97 helicopter hovering indicators and associated checkout equipment. The CW doppler principle will be explained to visitors by means of a colour/sound motion picture. Other airborne electronic equipment will be displayed and Ryan will use a film entitled the "Spirit of St. Louis" to illustrate the company's fine tradition in aircraft construction.

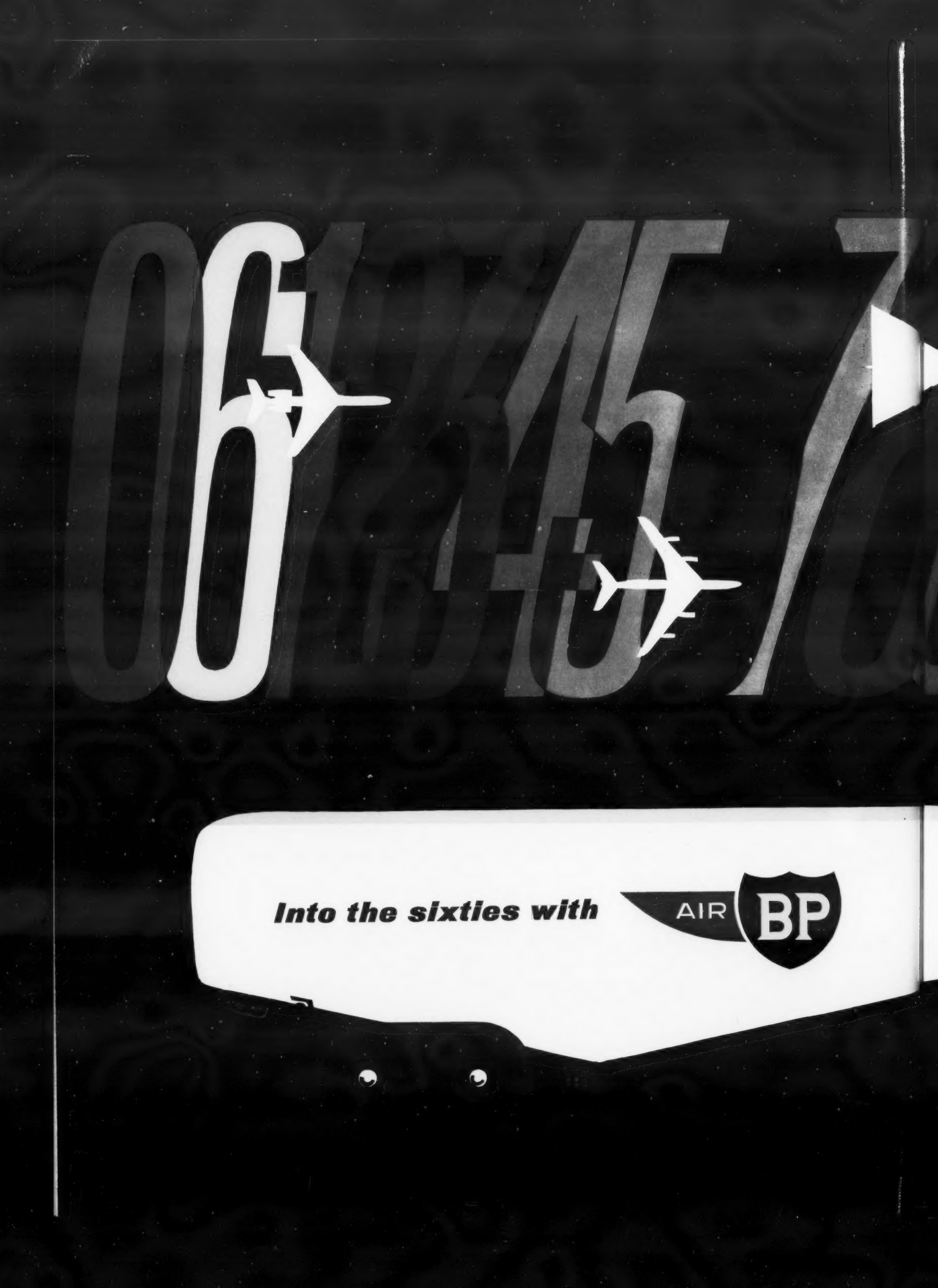
The Phoenix Company Division of the **Sperry Rand Corporation,** New York, N.Y. is presenting a new automatic flight control system for sport and light aircraft. This system, offered under the designation SP-3, consists of a basic installation, to which refinements can be gradually added. The Sperry Gyroscope Company will show a twin gyro platform, which is part of the equipment of the GAMD *Mirage* IV Mach 2 bomber. It is not yet possible to confirm whether the Sperry Utah Engineering Laboratory will be displaying the *Sergeant* Army missile.

Textron Inc., Providence, R.I., is showing products of its two subsidiaries, namely test equipment (the 165 and 180 supertesters) by California Technical Industries together with the T388 vibration test equipment and X-ray film camera (for recording the vibrations of enclosed parts) by MB Electronics.

All the divisions and subsidiaries of the **United Aircraft Corporation,** East Hartford, Conn., will by represented at Le Bourget. The Pratt & Whitney Aircraft Division is displaying a sectional full-size model of the JT3D turbofan engine; mock-ups of the JT8D and J58 jet engines; and of the RC-10 liquid propellant rocket engine; and a 1:4 scale model of the JT3C-6 jet engine. The Hamilton Standard Division will present a propeller with continuously variable camber; the PS-300 starter; a cutaway model of the JFC-27 fuel control system; two static inverters; air conditioning equipment for the Convair 880; a model of a control tower; and a model of a ground cart for the Convair B-58. The Norden Division will be showing various equipment, including inertial platforms, pressure ratio transmitters, and electromechanical components. The *Sikorsky Aircraft Division* will be demonstrating the turbine-powered HSS-2 amphibious helicopter in flight and showing models of the S-61D and S-64 helicopters, together with a mockup of the cockpit of the S-64. *United Technology Corporation* will bring models of the S-3, S-5 and S-10 rocket engines to Paris, and finally the Canadian Pratt & Whitney Aircraft Company Ltd., will be showing a cutaway model of the PT-6 propeller turbine.

The Boeing Airplane Company's **Vertol Division** is concentrating on displaying its Vertol 107 turbine helicopter. The numerous applications will be demonstrated in flight, in the static exhibition and by diagrams. It is not at present known what other helicopter Vertol will bring to Paris, but it is certain that the Vertol Division will conduct their campaign on the "helicopter as an autonomous weapons system" principle. →→

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The Problem of European Industrial Cooperation

By General Ferdinando Raffaelli, Rome

For the States of Europe, World War II ended the possibilities of independent national production of armaments in general and of aeronautical materiel in particular. In future, no European State will be able to rely on its own resources for the production of all the equipment necessary to the conduct of a modern war.

In other words, it would be very difficult, if not impossible, for a European nation to wage a modern war, or even to provide for the defence of its own territory, if it were obliged to depend entirely on its own industrial resources —even if the problem of raw materials were disregarded. The problem is, of course, largely one of economic capacity; but what is still more important is that the technical and industrial organization of a single country does not permit of all-round high quality production, i. e. production which can keep pace with technical progress in all its innumerable ramifications.

This is yet another of the consequences of scientific progress and of the well-nigh inconceivable technical progress which has left its mark on all military programmes since the end of the war, a progress whose effects are being most acutely felt in the field of aircraft and missiles.

What is more, the urgency of the need to prepare an effective defence system is continuing, in the course of this strange "hot peace," to harass not only military and financial experts, but also industrialists. Moreover, if we consider the condition of Europe after the holocaust of war, it is easy to see that the foundations for an industrial renascence such as the situation demanded were very shaky; for this reason the rearmament of Western Europe had to be carried out with the aid of the United States. But this aid could not last for ever; its basic aim was to give the nations of Western Europe time to organize production facilities which could make use of American aid under the terms of the assistance pact.

Continental Europe thus found itself in a completely new and highly complex situation in respect both of series production and of new technical methods. There seemed no alternative to renouncing domestic developments and importing aeronautical material from the USA and Great Britain. In the long run this dependence would have been anything but attractive.

Fortunately, another, much more logical, solution was forthcoming: *the industrial association of several European States*. In this manner it was hoped to distribute rationally tasks, which were insoluble for individual countries. It thus became possible jointly to exploit the markets and to avoid wasteful competition.

The States involved are no longer obliged to use up foreign currency resources for the acquisition of weapons, weapon systems, and accessories. They can finance their share of the common production in their own currency, and the tax payer has the assurance that the best possible use will be made of the credits authorized. Instead of each nation having its individual policy in the industrial field, there is now a Continental European policy which will have more and more influence in the whole field of research and development. The creation of a common organization for the production of complex missiles and combat aircraft of this kind, naturally goes far beyond normal demands of national planning in individual States. Moreover, the general political situation in Western Europe was not exactly favourable to an undertaking of this kind, but the "cold war," which was constantly becoming hotter, strongly demanded a solution and those responsible were obliged, whether they liked it or not, to join together to find a workable arrangement.

Before 1950 certain bilateral agreements had already been reached and although these may, in retrospect, look modest, they prepared the ground for the later multilateral organization. As an example we might cite the Italo-French production of the British DH *Vampire* fighter.

Finally AICMA (International Association of Aircraft Constructors) was formed, which played a decisive part in the preparation of international cooperation. The ice was broken and the way paved for industrial links between various States, such as France/Germany, Belgium/Netherlands, Italy/France, Italy/Germany. Although these *rapprochements* in the first place were limited to bilateral agreements, they served to create a climate of general agreement. Construction of the Fiat G.91 represented an important step in this direction: Germany, Great Britain, France, and Italy participated in the production of this aircraft, which has already been in operation for two years.

In the last three years, this cooperation has led to four significant developments which are at present in progress, and which are in no way limited to the military sector. These are the *Hawk, Atlantic, Caravelle* and F-104. In other words, we are now far beyond the modest beginnings of the bilateral industrial agreements. This new construction phase, which started in 1958, has already involved several thousand million dollars. These multi-lateral, predominantly European, projects—in which, of course, the USA is also cooperating—have given a flying start to Continental European production. The object remains continual expansion of this community, both in respect of the number of member States and in respect of the range of construction projects.

Is there anything still to be desired of this imposing organization from Continental Europe's point of view? Well, there is still no agreement about coordination, and an extended period of practical experience is necessary before judgment can be pronounced. At present, the organization is not a unified one embracing all industries, but a collection, more or less loose, of *ad hoc* associations for individual development projects, although the European Production Groups created within the framework of NATO are likely to be strictly controlled according to NATO principles. What is still wanted, therefore, are links which constantly get closer and yet, if possible, remain flexible, with the object of exploiting the "time" factor to the full. To be sure, the measures to date have taken account of this necessity and, wherever possible, short cuts to the objective have been used. But if one considers how quickly, in our time, even the most modern weapons become obsolete—and this is particularly true in the aviation field—one can only hope that bureaucracy does not get the upper hand and that success is not endangered by administrative clumsiness.

The third phase of European cooperation is before us, a phase which ought to be characterized by stabilization and improvement of the organization by speeding up the methods of working and raising output.

The fact that the way is being paved for the unification of the European aeronautical industry is a welcome source of encouragement at the present time. It could indeed be a blessing to the whole economy of the Old Continent and to the co-existence of the countries it embraces. ←

European Shop-Windows

The fact that the Union Syndicale des Industries Aéronautiques is continuing, as before, to welcome the aircraft industries of Europe and America at Paris, is a sign not only of the French desire for international collaboration, but also that there is a growing need to show what can be done on an international scale in the field of aviation and astronautics. Some 250 exhibitors from twelve countries will be assembled this year at Le Bourget Airport.

As will be seen from the article on page 610, the Americans know how to take advantage of the opportunity. Nor is there any doubt that the products of the European countries—despite the great variety of methods applied in their industries—on the whole reflect the same level of efficiency. Whether, however, the bewildering variety of exhibits holds out any hope of rationalizing resources and standardizing European programmes, will become clear only after a visit to the Paris Air Show.

• Great Britain

In the two years since the last Paris display, the British Government and the aircraft industry have swung heavily towards interdependence and European cooperation.

The lost years have been difficult to make up, particularly in the face of strong American competition, but the effort has been made and the first rewards may be around the corner. A joint European space programme with Franco-British second and first stage rockets now appears possible; while British and German talks may lead to a developed Hawker 1127 as a first stage in the long-term NATO VTO programme. At the same time, the invisible but nevertheless very real import barrier into the United Kingdom has been broken with the British army purchase of *Alouette* helicopters.

The 1961 Paris Air Show will see no less than 53 British exhibitors and the industry in its Sandys-amalgamated "big-group" form. Hawker Siddeley will display the wares of seven of its member companies, while the British Aircraft Corporation main firms number four.

There will be considerable sales tacivity on the part of both these giants, as several of their major civil and military development programmes are now nearing fruition. The Hawker 1127 has flown and is progressing towards transition, the DH.121 *Trident* may fly in October—two months ahead of schedule—while the Blackburn NA.39 *Buccaneer* is due in service next year. At BAC the VC.10 is to fly in 1961, as is the Mach 3 test vehicle, the Bristol 188. The supersonic M 2.2 airliner and the M 2.5 TSR.2 strike reconnaissance aircraft are now at the advanced design stage, and the group has embarked upon new small jet airliners, the BAC.107 and BAC.111.

The British Aircraft Corporation exhibit will cover the products of the group companies; English Electric Aviation, Vickers Armstrongs (Aircraft) Ltd., Bristol Aircraft Ltd., and Hunting Aircraft Ltd. Models of the wide range of aircraft produced by the group will be displayed on the stand including the *Viscount, Vanguard, VC.10,* BAC. 107, *Bristol 188* and *Lightning*. Also on display will be a *Jet Provost* trainer and a *Vigilant* anti-tank weapon with training simulator. In the rocket field one of the most interesting exhibits will be the solid-propellant *Blue Water* artillery missile, to be shown publicly for the first time. This missile, together with a battery of *Thunderbird* anti-aircraft rockets, manned by detachments from the British Army, will be set up in the guided weapons park.

Hawker Siddeley Group Ltd. will show the products of the following companies: A.V.Roe, Armstrong Whitworth, Blackburn Aircraft, Hawker Aircraft, Gloster Aircraft, de Havilland Aircraft and de Havilland Engines. Aircraft at the display will include the *Comet 4B, Dove, Heron, Beaver, Caribou,* two-seat *Hunter, Gnat Trainer, Buccaneer, Avro 748* and *Argosy C.1*. Models on the stand will cover the whole range, and there will be an area showing Group subsidiary products such as the Folland ejector seat. Astronautics exhibits will be featured on a separate stand. Missiles on display may include the latest version of the *Firestreak*, "*Red Top*," while the *Seaslug* which is produced in cooperation with GEC and Sperry will be displayed in the missile park.

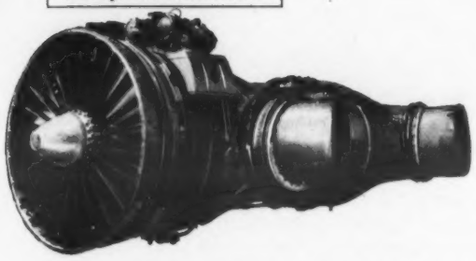
The engine products of the group will consist of the de Havilland *Gnome* turboprop, the coupled *Gnome* and *Gnome* shaft engine, the Blackburn AAPP engine, and the *Turmo* and *Nimbus*. De Havilland will also show the propeller for the Breguet *Atlantic*.

Four other aircraft manufacturing companies will be present in Paris. **BEAGLE-Auster Aircraft Ltd.** will have an aircraft flying at the Salon, and a furnished BEAGLE-Auster fuselage and various models will be on display at the stand. **Handley Page Ltd.** ist not taking a stand in the exhibition hall, but the company will be showing a *Dart Herald* Series 200 on the airfield.

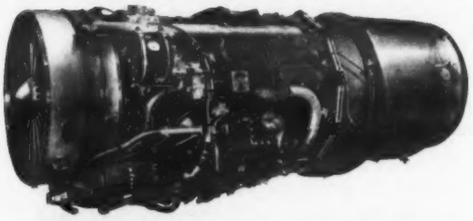
Short Brothers and Harland Ltd. will demonstrate VTOL and transition flight with the SC.1 research aircraft in much the same way as at Farnborough in 1960. On the stand will be models of VTOL aircraft, a model of the Short *Belfast* freighter, a display outlining the new Short freight handling system for cargo terminals of the future, and a model of the Short SC.7 *Skyvan* light freighter. In the guided weapons park a sectioned model of the *Seacat* close-range guided missile will be displayed together with a 1/10 scale model showing the *Seacat* launcher loaded with four missiles and the director mounted on the deck of a destroyer.

All helicopter development in the U.K. is now centred on **Westland Aircraft Ltd.**, and the

The order placed by the Government of Ghana for 3 Vickers VC.10 jet airliners was the first export order received by the British Aircraft Corporation for this new aircraft. The first VC.10 off the production line is scheduled to fly in 1961.

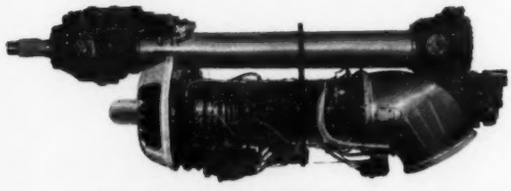


The Bristol Siddeley BS.53 lift/thrust ducted fan engine which is the powerplant of the Hawker P.1127.

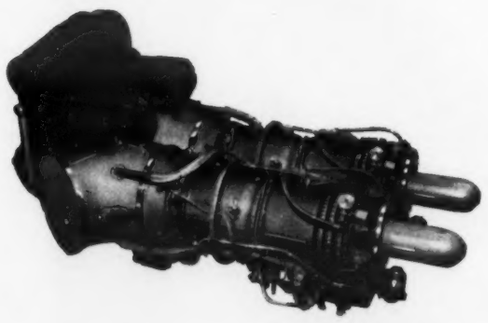


The 17,500 lb thrust Rolls-Royce *Conway* by-pass engine. This engine is at present in service in the Douglas DC-8/40 and Boeing 707/420 airliners and is specified for the Vickers VC.10.

The Bristol Siddeley BS.75 ducted fan engine of 7,350 lb thrust. This engine has a high by-pass ratio of 1.75 : 1 and has been specified as the powerplant for the BAC.107.



The turboprop version of the de Havilland *Gnome*. This engine consists of a basic *Gnome* with a drive shaft and epicyclic reduction gearing driving a de Havilland Hydromatic propeller.



The coupled *Gnome* installed in the Westland *Wessex 2* helicopter. The two powerplants are connected to a common gearbox with a freewheel enabling the units to be operated singly if required. The weight is 1,034 lb. and the total power 2,500 s.h.p.

company is planning to send five machines, including the *Rotodyne* "*Y*." The others are all in current production and will comprise the 5–6 seat *Nimbus*-engined *Scout* on order for the British Army, the *Whirlwind* Series 3 now being produced for the RAF and the Republic of Ghana, the *Gazelle*-engined *Wessex I* now entering service with the Royal Navy, and finally the latest addition to the helicopter strength of the RAF; the twin *Gazelle*-engined, twin-rotor *Belvedere*.

In the static exhibition Westland will have a stand exhibiting models of all the helicopters now in the Westland range. There will also be shown a model of the SRN.2 *Hovercraft*, a 27 ton, 66 passenger craft now under construction at the company's Isle of Wight factory.

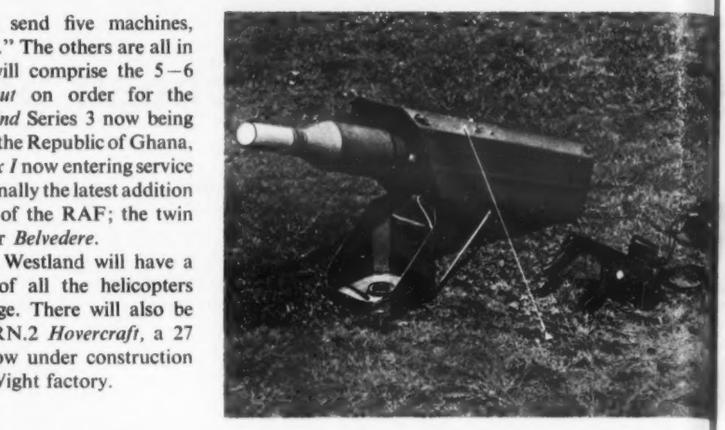
The Engine Constructors

British engines continue to power many new British and European aircraft types, and both Rolls-Royce and Bristol Siddeley will be stressing their work in the VTO field, the former with "battery" engines and the latter with the combined forward thrust and vertical lift rotating nozzle BS.53. The merits of different by-pass ratios will continue to be a subject of discussion, more particularly in the cases of the BS.75 with a 1.75 : 1 ratio and the RB.163 *Spey* with its 1 : 1 ratio.

Bristol Siddeley Engines Ltd. will also exhibit the *Olympus*, *Orpheus* and *Viper* turbojets, the *Proteus* turboprop and the *Stentor* and *Gamma* rocket motors. A ramjet engine will also be on display in the static park.

Rolls-Royce Ltd. has selected examples of both military and civil engines for the exhibition. These include the RA.29/6 turbojet, *Conway R.Co.12* by-pass engine, RB.146 *Avon* military engine with reheat, RB.163 *Spey*, and two RB.108s and an RB.145 in a VTOL configuration. Two Continental piston engines will also be on display.

Alvis Ltd. is not engaged in the production of turbine aircraft engines, and the company's exhibit will be devoted to the *Stalwart* and *Saracen* cross country vehicles. The *Stalwart* is suitable for ammunition, supplies, radar and weapon carrying.



The *Vigilant* anti-tank missile ready for launching from the combined launcher and carrying canister. The sight-controller at the right carries a monocular sight and controls for the operator to command the wire-guided missile to the target.

Electronics and Equipment Manufacturers

Many of the items on the equipment stands will be new, and it is remarkable how many British firms have cross-licencing agreements with European companies. The equipment industry has long been aware of the benefits of mutual cooperation. The following review can give only a few examples of the wide variety of equipment which will be on display in Paris.

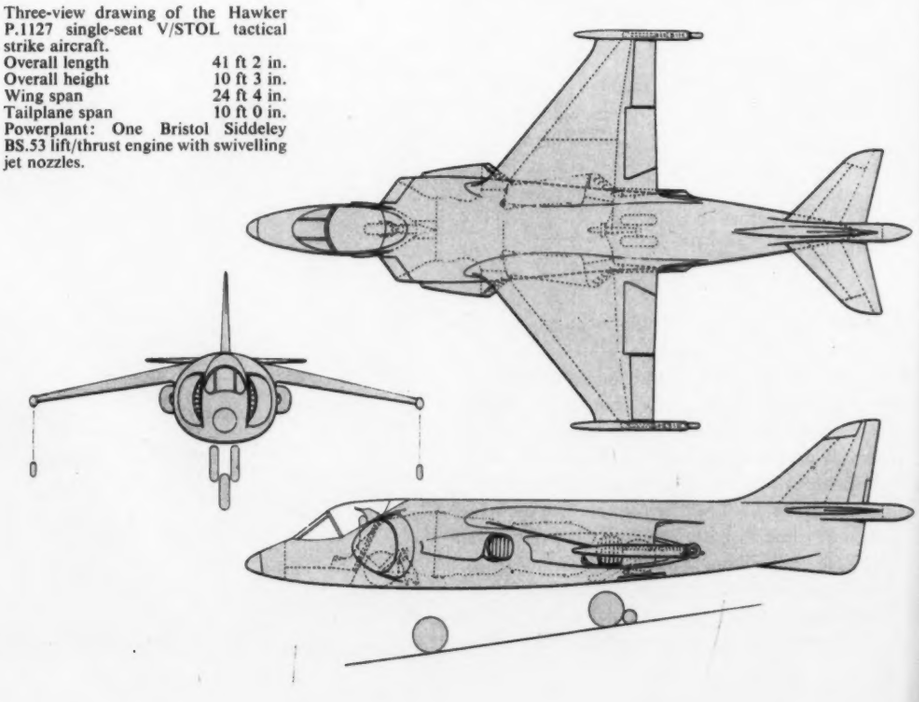
Bristol Aerojet Ltd. Rocket motors welded and wrapped, and welded, from 7.22 in. to 17 in. Rocket tubes in titanium, stainless steel, zirconium, Monel, Nimonic and aluminium. Nine types of pressure vessel. Plastic components including tubes, nose cones and expansion cones. Examples of chemical contouring and mock-up of a glass fibre meteorological rocket.

British Oxygen Aviation Services Co. Ltd. Aircraft breathing equipment ranging from a 25 litre liquid oxygen converter package unit to a new portable oxygen breathing system for light aeroplanes which will be shown for the first time

Three-view drawing of the Hawker P.1127 single-seat V/STOL tactical strike aircraft.

Overall length	41 ft 2 in.
Overall height	10 ft 3 in.
Wing span	24 ft 4 in.
Tailplane span	10 ft 0 in.

Powerplant: One Bristol Siddeley BS.53 lift/thrust engine with swivelling jet nozzles.



by British Oxygen Aro Equipment Ltd. The stand will also feature equipment made by Aro Firewall—the American associate company.

Ciba (A.R.L.) Ltd. The main theme of the exhibit will be 'Redux' adhesives in metal-to-metal bonding with examples of components from the *Alouette* and *Friendship*, 'Aeroweb' metal honeycomb core with sections of control surfaces, floorboards, and other components.

Cossor Radar and Electronics Ltd. On the stand of C.T. (London) Ltd., Cossor civil secondary radar airborne transponder SSR.1251 with a range of 180 nautical miles at 30,000 ft; CR 787 mobile medium range S-band radar; *Icarus Mk.2*, an inexpensive radar reflector for meteorological use.

Decca Navigator Co. Ltd. Navigational equipment such as Decca Navigator on the stand of CSF. The display will feature technical and industrial cooperation between Decca and its European associates.

The Fairey Co. Ltd. The exhibits of four subsidiaries of the Group.

Fairey Engineering Ltd. (Weapon Division). Del Mar RADOP towed-target systems, subsonic and supersonic for air-to-air and surface-to-air guided weapon training; *Malkara* anti-tank guided weapon; *Jindivik Mk.2B* pilotless target aircraft. *Fairey Engineering Ltd.* (Hydraulics Division). Range of hydraulic power controls and microfilters. *Fairey Air Surveys Ltd.* Cameras for target aircraft, guided weapons and reconnaissance aircraft. *Siebe, Gorman & Co. Ltd.* Safety and rescue equipment, including breathing apparatus for fire-fighting; fire-resistant clothing; passenger seat belts.

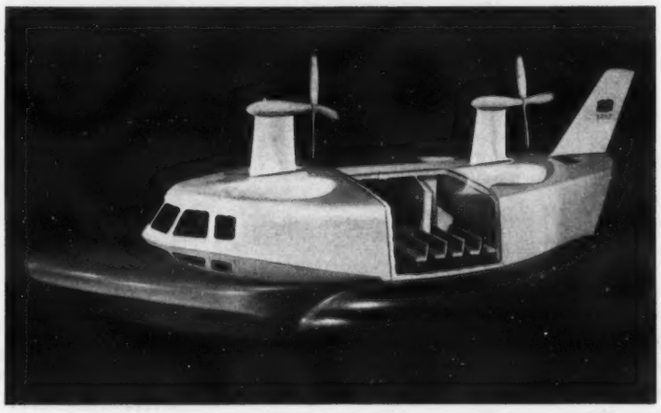
Ferranti Ltd. Products of the Scottish group of factories including *Airpass* (Airborne Interception Radar and Pilot's Sight System) and the light fighter sight for aiming guns, rockets or bombs against surface targets, as well as guns or rockets in air-to-air combat. From the aircraft equipment department, a transformer-rectifier unit—TR 500 as used in the *Vanguard*; vertical reference gyro —FS.16; standby artificial horizon (F.H.7. series); standby gyro system; Kearfott accelerometer; and Kearfott azimuth gyro. Also shown are semiconductor devices, transformers, chokes and potentiometers, and microwave components.

Graviner Manufacturing Co. Ltd. A lightweight smoke detector; smoke viewer for monitoring up to 5 compartments; the Firewire detector; fire extinguishers; pressure relief indicators; hand extinguishers; the heavy landing indicator.

High Duty Alloys Ltd. Will show examples of aluminium alloy forgings manufactured for Continental aircraft constructors. Among these are components for Hispano-Suiza, Fokker, Messier, FIAT, Messerschmitt and Nord-Aviation. Also on show will be turbine and compressor blades in a wide range of materials, aluminium alloy sheet exhibits, a display of aluminium alloy extruded sections, and sand and gravity die castings.

H.M. Hobson Ltd. The firm's exhibit will include a pair of tandem piston jacks type 194, feel simulator unit type 385, camber flap control as fitted to the *Caravelle*, flap control unit from the *Argosy*, feel simulator controls and jacks, powered flying controls, fuel flow proportioners, constant speed alternator drive, ramjet air/fuel ratio control, electro-hydraulic system actuators, hydraulic pumps and motors.

The Avro 748 feeder liner powered by two Rolls-Royce *Dart* engines. To date the manufacturers have received firm orders for 24 aircraft.



A model of the SRN.2 *Hovercraft*, designed and being built by the Saunders-Roe Division of Westland Aircraft Ltd. as a joint venture between the National Research Development Corporation and Westland Aircraft Ltd.

The *Salamander* fire and crash tender produced for the RAF by Alvis Ltd. The cross country chassis enables the vehicle to negotiate rough terrain in the vicinity of an airfield to arrive at the scene of an accident with the minimum delay.

Martin-Baker Aircraft Co. Ltd. The company's exhibits, which will form part of the Hispano-Suiza group stand, will be a Mk.AM4 ejection seat manufactured in France by Société des Exploitations des Matériels Martin-Baker, a company formed jointly by Martin-Baker and Hispano-Suiza. There will also be a Martin-Baker Mk.H5 seat and the prototype rocket assisted ejection seat especially suited for VTOL aircraft.

Normalair. The company is showing a wide range of pressurization, air conditioning and oxygen breathing equipment. The centrepiece will be an animated, twice full size, perspex model of the cabin air compressor which forms one of the major components of the air conditioning and pressurization systems being supplied by Normalair for installation in the Weser Nord *Transall C.160* military transport aircraft. Other items include equipment being supplied for the Vickers VC.10. A further range of Normalair equipment including cold air units, water extractors, pressure controllers, temperature control valves etc. will also be displayed on the Breguet-Garrett stand, which will be combined with the display stands of the Garrett Corporation of America and Normalair Ltd., to form an integrated display.

These few random examples are indicative of the wide variety of equipment which British firms will exhibit at the Paris Salon, and it is noteworthy that in several instances there already exists a commercial agreement between a French and a British company. ←

The two Fiat aircraft in production for NATO: The G.91T two-seat trainer (left) and the G.91 lightweight strike fighter (with auxiliary fuel tanks in picture).

Italy

Italy will be represented at the Show by the products of Aerea, Aerfer, Aeronautica Macchi, Alfa Romeo, Bombrini Parodi-Delfino, Costruzioni Aeronautiche Giovanni Agusta, Fiat, Meteor, Microtecnica, Piaggio, and Procaer, which will provide a general picture of the many facets of her aviation industry. Construction of aircraft within the framework of a national production policy, of helicopters, of engines, of missiles, of equipment and of accessories used both at home and abroad, licence construction of foreign engines or airframes and the overhauling of such engines or airframes under industrial agreements for technical cooperation or as part of Italian participation in NATO, are the main activities to be covered. An important part is played by the Associazione Industrie Aeromissilistiche in coordinating the Italian exhibits.

*

Fiat Aviazione will cover the aircraft activities which it is undertaking as part of increasingly close European cooperation. The Fiat G.91 light tactical strike aircraft, which sprang from a NATO competition and is equipped with a Bristol Siddeley *Orpheus* turbojet (4,970 lb thrust), is at present built in three versions, namely the G.91 R/1 for the Italian Air Force, armed with four 12.7 machine guns, the G.91 R/3 for the West German Air Force, with two 30 mm guns, and the G.91 R/4 for the Greek and Turkish Air Forces. Each version is suitable for tactical support, photo reconnaissance or armed reconnaissance.

A further development, the Fiat G.91T two-seat trainer, has been ordered by the Italian and West German Air Forces and carried out its first flight on May 31st, 1960; its maximum horizontal speed is 667 m.p.h. In ease of control and versatility it is the equal of the G.91.

The Fiat 7002 helicopter, a model of which was exhibited at the 1959 Show, will this time be on view at the prototype stage. The 7002, which made its first flight on January 26th, 1961, and is on order for the Italian Defence Ministry, is the first helicopter designed and built by Fiat. It is powered by a Fiat 4700 550 h.p. turbogenerator, with a twin-blade rotor and a small rear anti-torque rotor. The cabin is designed to hold six passengers, not counting the pilot. Total weight is 3,080 lb, cruising speed is 84 m.p.h. at sea level and range 188 miles.

Fiat will also be showing one of the intended versions of the Fiat G.95, the STOL design conceived by Professor Gabrielli, head of Fiat's aeronautical division. As is already known, the configuration in question is a new one, said to make possible considerably shorter take-off and landing distances, without thereby affecting the aircraft's other characteristics, in particular its maximum speed.

Mention should also be made of the fact that Fiat is building certain parts of the Sud-Aviation *Caravelle*, of the Lockheed F-104 and of the Sikorsky S-58.

The engines on show will be the Fiat 4700 (three versions) built on the order of the Italian Defence Ministry, the shape and dimensions of which have been studied in connection with its use in a vertically mounted position, the Bristol Siddeley *Orpheus* and the General Electric J79, both the latter being built by Fiat under licence.

Fiat Aviazione will also give a picture of its activities in the missile and electronic fields and of its participation in the European construction programme for the *Hawk*.

A Rolls-Royce *Dart* propeller turbine on the Alfa Romeo test stand at Pomigliano d'Arco. The company's overhaul workshops are later to be fitted with test equipment for jet engines with thrusts of up to 31,000 lb.

*

The two-seat Macchi MB.326 jet trainer, the first-stage trainer being produced by this well-known company, whose base is at Varese, for the account of the Italian Air Force, is equipped with the Bristol Siddeley ASV. 11 *Viper* jet (built in Italy by Piaggio); it can reach a speed of 506 m.p.h. at 20,000 ft and its range is some 625 m. Aeronautica Macchi is also responsible for production of the Lockheed CL-402 *Santa Maria* for the European, African and Middle East markets. This is a light, all-metal communications or work aircraft (fitted with a Continental engine which is available in normal or supercharged versions) with a total take-off weight of 3,520 lb, which carries 5 to 6 passengers, with a range of 500 miles at its cruising speed of 125 m.p.h.

*

Aeronautica Macchi has also concluded an agreement with Sprague Engineering Corp., under the terms of which the Italian concern will manufacture the American company's products, test and maintenance instruments for aircraft and

missiles, under licence in Italy. For this purpose, Macchi has set up in its Varese plant a special division for the manufacture of Sprague equipment and machines. Amongst the items in question are test installations for the IM-99B *Bomarc* and *Atlas* rockets.

*

Over the last five years **Costruzioni Aeronautiche Giovanni Agusta** has manufactured about 450 helicopters in its works at Cascina Costa, Gallarate, and of these 75% have been exported. Current production comprises mainly the Agusta-Bell 17G-3 *Super Alpino* and the Agusta-Bell 47J-3 *Super Ranger*. The first of these is equipped with a Franklin 6 VS 335A and has a maximum speed of 110 m.p.h. at 15,700 ft and 2,400 lb total weight; the second has a Lycoming VO-540B engine. Agusta is also building the Agusta-Bell 204B twelve-seat helicopter under licence, this being equipped with the de Havilland *Gnome* shaft turbine engine.

Agusta's proprietary list includes, amongst other items, the Agusta 101-G with 3 de Havilland *Gnome* turbines, capable of carrying 30 passengers for 310 miles at a cruising speed of 110 m.p.h. (a prototype of this has been ordered by the Italian Air Force); the single-seat Agusta 103 with an 85 h.p. Agusta Verghera engine; and the Agusta 102, which can carry 8 to 10 passengers at the normal speed of 108 m.p.h. with a range of 287 mi.

A new type of helicopter is the 2-seat Agusta 104, developed from the Agusta 103, with a 180 h.p. Agusta Verghera engine, empty and fully-loaded weights being 836 lb and 1,408 lb respectively, and cruising speed 81 m.p.h.

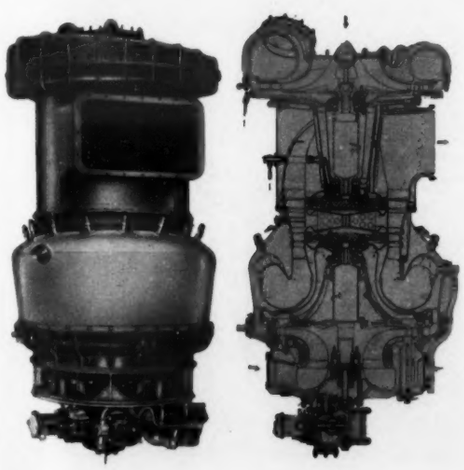
*

Amongst the various productions of **Piaggio** is the P.166 executive aircraft with 2 Lycoming GSO-480-B61C engines with supercharger, giving altogether 680 h.p. (engine produced by the Piaggio works at Finale Ligure under licence), which can carry 6 to 10 persons (the 10 person "high density" version is the most popular) over a maximum distance of 1,125 mi and is in regular use by Deutsche Taxiflug and Deutsche Nahluftverkehr A.G.; the standard version can be easily and quickly converted to a medical or cargo version. Several P.166's have been specially equipped for aerial photography. The amphibious

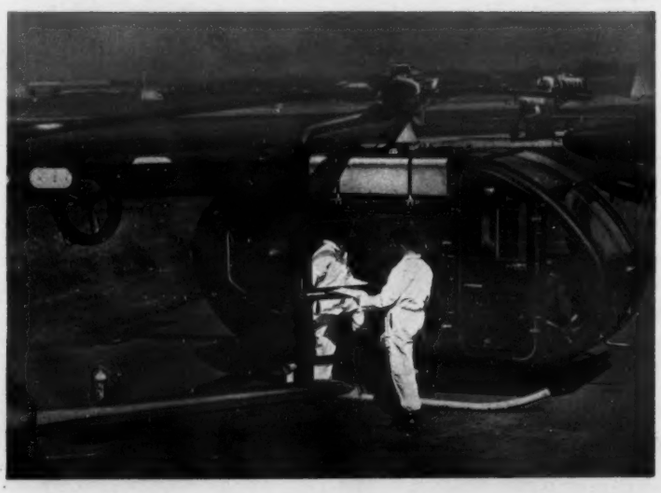
The Piaggio P.166 six- to eight-seat business aircraft is powered by two Lycoming GSO-480 engines with superchargers, each of which drives a three-blade metal propeller.

Aeronautica Macchi is licence manufacturer of the Lockheed CL-402 transport and communications aircraft, designed to carry five passengers or 1,320 lb of freight; the cabin has a volume of 120 cu.ft.

The Procaer F.400 *Cobra* four-seat touring aircraft.



The Fiat 4700 compressed air generator supplies compressed air to drive the tip-driven rotor blades of the Fiat 7002 helicopter.



The Fiat 7002 helicopter, which made its flight at Caselle near Turin, on January 26th this year, has a gross weight of 3,100 lb. The main rotor is 40 ft in diameter. The cabin can accommodate five passengers and two pilots.

twin-engine Piaggio P.136-L2, a development of the P.166, has been very successful in the USA, where it is sold under the name of *Royal Gull*, and several aircraft have been ordered by the Far East and Middle East.

Amongst various equipment produced by Piaggio, the 3-blade P.1033-G4/PS propeller should be mentioned. It is 8 ft 1 in. in diameter, weighs 107 lb, and is used in the P.166.

*

Progetti Costruzioni Aeronautiche (Procaer) of Milan makes two small touring aircraft, the F-15/B and the F.400 *Cobra*. The first of these is a 4-seater with a Lycoming O360-A1A propeller engine and the second a 2-seat sport and touring model, fitted with a Turboméca *Marboré IIF* turbojet with 880 lb thrust. The body of this aircraft is made of plywood panels covered with thin aluminium sheets, according to the technique already proven in the F.15, its cruising speed at 13,200 ft is 310 m.p.h. and its range 625 mi (812 mi with auxiliary tanks).

*

Microtecnica will of course be exhibiting high precision gyroscopes which are its speciality, synchronous motors of 400 and 600 cycles per second, heat exchangers, electronic cabin temperature regulators, safety valves and cabin pressure regulators, air conditioning plants, and wave guides for radar.

*

Aerea will show special practice bombs and plastic tanks for holding either fuel (extra tanks for the Fiat G.91) or napalm. The tanks hold 500 lb.

*

Alfa Romeo will present its aeronautical activities in photographic form. This Milan company has made important agreements with Curtiss-Wright on the one hand and Rolls-Royce on the other, whereby it assumed responsibility for overhauling R.3350 and R.1820 engines as well as *Dart* turboprops and *Avon* and *Conway* turbojets.

*

Aerfer will provide an important record of the work it carries out for NATO account in the manufacture and overhaul of spare parts for the Republic F.84 RF.

*

Meteor will exhibit both engines, including two-stroke direct injection and supercharged engines, and radio-controlled propeller drones with a speed of about 300 m.p.h. and a ceiling of 43,000 ft; one of these missiles, the Meteor P.2, is specially for battlefield observation and tactical reconnaissance. →→

• German Federal Republic

For the second time since the war the Federal German aircraft industry is represented at the Paris Air Show. Although its contribution in 1959 was a modest one, this year the main firms will either have stands of their own or exhibit their products on a stand of the Federal Association of the German Aircraft Industry (BDLI).

As was the case two years ago, the renascent German industry depends largely on the licence production of military aircraft—nearly all the manufacturers are taking part in the Lockheed F-104G *Starfighter* programme. Nevertheless, the firms represented in Paris have shown that, although their contributions are in some cases modest, they do not lack initiative and enterprise in evolving new designs. And this despite the lack of Government support for civil developments.

If the following ABC of exhibitors deals rather summarily with the major concerns, this is due to the number of new companies represented.

BMW Triebwerkbau GmbH, Munich (capital DM 20 million = $5 million, held 50% by Maschinenfabrik Augsburg-Nürnberg AG, and Bayerische Motorenwerke AG, Munich). After years of financial difficulties, the firm has only recently been able to devote itself to major tasks. Its present activity extends to the licence production of the General Electric J79 jet for the F-104G; the development of small gas turbines; projects for small by-pass engines to power training, sports and touring aircraft; and VTOL powerplant projects.

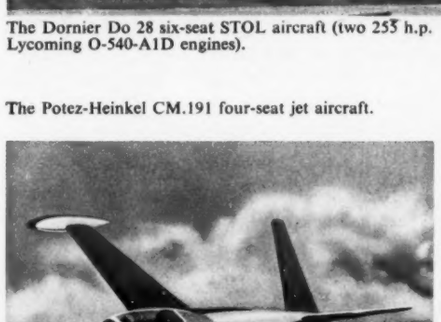
The 6012 small gas turbine with axial compressor (rating 90 h.p., weight 100 lb) which will be exhibited at the Paris Air Show, is a derivative of the 6002 developed some years ago. BMW Triebwerkbau GmbH is also developing another derivative of the 6002, the 8025, but at the time these lines went to print it was not yet known whether this would be exhibited. In addition, BMW will show the GO-480-B1A6 piston engine (built under Lycoming licence) at Paris.

Bölkow-Entwicklungen KG, Ottobrunn, Munich: A firm founded after the war, which rapidly won international recognition for the originality of its designs, Bölkow produces electronic equipment, anti-tank rockets and accessories (at Nabern, near Kirchheim/Teck) and sports aircraft (at Leipheim, near Ulm). The firm will present details, and perhaps a model, of its two-stage high-altitude research rocket, still under development, which is designed to reach a height of 50 miles. Both stages can be recovered by parachute. A developed version of this rocket will contain an autopilot to enable it to return to its launching site. Also on show for the first time will be a model of a high-speed helicopter with Derschmidt rotors. Other exhibits will be the *Cobra* weapon system and the Bö 102 *Heli-Trainer*. Finally, the Bölkow F-207, derived from the Klemm 107, will be demonstrated; this is a low-wing aircraft of wooden construction, making large-scale use of plastics (180 h.p. Lycoming engine with variable-pitch propeller).

Dornier-Werke GmbH, Munich/Friedrichshafen (capital DM 8 million = $2 million, owned by the Dornier family). Dornier's production programme is many-sided: participation in licence production of the F-104G and Fiat G.91 (the latter is assembled and test-flown at Dornier); construction of the Do 27 (brisk export sales for civil and military applications); production of the Do 28; Do 29 research programme under contract to the Federal Ministry of Defence; VTOL developments (from the Do 30 STOL transport project

The Dornier Do 28 six-seat STOL aircraft (two 255 h.p. Lycoming O-540-A1D engines).

The Potez-Heinkel CM.191 four-seat jet aircraft.



the Do 31 is being developed—this is designed as a VTOL combat zone transport which Dornier is offering to the German Air Force and perhaps, eventually, to NATO); development work on a single-seat helicopter; share in the production of the Breguet *Atlantic*. The six-seat Do 28 with two 255 h.p. Lycoming O-540-A1D engines and Hartzell propellers, modified since the last Paris Air Show, will be exhibited.

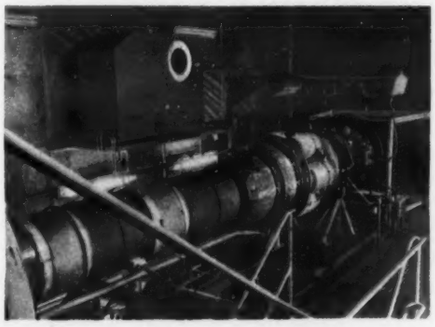
Focke-Wulf GmbH, Bremen (capital DM 3 million = $750,000, of which 31% is held by Standard Elektrik Lorenz AG, Stuttgart and 27% by the Roselius Group, Bremen). The company, which forms part of the Arge Nord, is working on licence production of the F-104G. It also has a number of VTOL projects in hand, including one for a VTOL airliner with 16 lift engines, and a variety of other civil and military projects. Among the exhibits at the Paris Air Show will be plastic parts and a model of a VTOL design.

Hamburger Flugzeugbau GmbH, Hamburg (capital DM 5 million = $1.25 million, owned by the Blohm family). Working in cooperation with Weser Flugzeugbau GmbH and Siebel-Werke, HFB has delivered a total 129 Nord 2501 *Noratlas* transport aircraft to the Air Force since 1958. Production will be phased out in August this year. HFB is working with Nord-Aviation and Weser Flugzeugbau on the development of the *Transall* C.160; as a member of Arge Nord, the company is producing parts for the F-104G; it also carries out conversion and maintenance work (conversion of Convair 440s into staff aircraft for the Air Force, and equipment of Air Force Douglas C-47s and de Havilland *Herons* with modern radio and navigation equipment). At the Air Show, HFB will be exhibiting the *Sky Swing* and *Sky Couch* passenger seats, which it has developed and is producing, and which are already in use in the aircraft of a number of airlines.

Ernst Heinkel Flugzeugbau GmbH, Speyer/Rhein (capital DM 5.1 million = $1.27 million dollars, owned by the Heinkel family). The company is continuing an old tradition of aircraft production. After producing the Fouga *Magister,* Heinkel is building the Fiat G.91 and the F-104G under licence. The long-cherished dream of developing the *Magister* jet trainer to a four-seat aircraft has now become a reality, as the Federal Ministry of Defence has placed the necessary contract. The aircraft will be developed and produced jointly with Potez-Air Fouga. The CM.191 prototype will have its first public showing in Paris. Further projects are the He 211A, B and C for the civil market, the Entwicklungsring Süd VJ 101 and other aircraft for the military market.

Henschel-Flugzeugwerke AG, Kassel (capital DM 0.5 million = $125,000, owned by Henschel-Werke GmbH, Kassel). A maintenance and repair depot for helicopters, in particular Air Force Sikorsky H-34s and Sud-Aviation *Alouette IIs,* has been in existence since 1957 at the Henschel-Werke GmbH in Kassel. Henschel-Flugzeugwerke will show a cross section of this activity at the Air Show.

Interior layout of a Convair 440 converted by Hamburger Flugzeugbau under contract to the Federal Ministry of Defence.



A jet engine test stand of BMW Triebwerkbau GmbH.

Wind-tunnel model of a Derschmidt type high-speed rotor developed by Bölkow.

Klöckner-Humboldt-Deutz AG, Ulm works (branch of Klöckner-Humboldt-Deutz AG, Cologne; capital DM 70 million = $17.5 million, majority holding in the hands of Klöckner & Co., Duisburg). Bristol *Orpheus* jet engines are built under licence at the Oberursel/Taunus plant. There has recently been talk of a tie-up with General Electric with a view to developing and producing small turbines, though this will not be reflected at the Paris Show.

The Ulm works, also known as the "Magirus works," will be presenting the *Orion 70* (70 h.p. Deutz diesel engine and Voith fluid transmission) and *Orion 250* (250 h.p. 12-cylin der Deutz diesel V engine with Voith gearbox).

Merckle-Flugzeugwerke GmbH, Oedheim, near Heilbronn / Württemberg: This relatively young company develops helicopters and is looking for a market for the Merckle *Kiebitz 501* sports aircraft, designed by Professor Winter of Brunswick, so that it can begin production. Pictures and models illustrating the company's activities will be shown at Paris.

Messerschmitt AG, Augsburg (capital DM 10.5 million = $2.63 million, owned 49% by the Province of Bavaria, 49% by the Messerschmitt Group and 2% by the German Federal Republic). This concern, too, began with licence production after the war. In addition to the manufacture of parts at Augsburg, the Fouga *Magister* is assembled and test-flown for the Air Force at Munich-Riem. This small facility is now being disbanded, as a new one is being built at Manching, near Ingolstadt, with Federal funds. Here the final assembly of Arge Süd-built F-104Gs will take place. Messerschmitt's activities in this field will be illustrated at the Paris Air Show by pictures and models. There will, however,

Republic F-84 F fighter-bombers receiving a thorough overhaul at the Lemwerder plant of Weser Flugzeugbau GmbH.

Klöckner-Humboldt-Deutz is showing the *Orion 250* aircraft towing vehicle at Le Bourget. The vehicle is powered by a 250 h.p. Deutz diesel engine with Voith gearbox, and can tow a maximum load of 352,000 lb.

be no exhibits connected with the Entwicklungsring Süd VJ 101 VTOL combat aircraft project, of which Messerschmidt is coordinator.

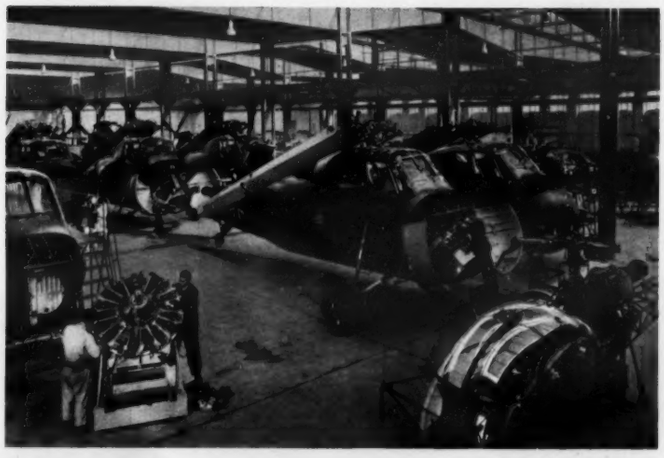
Rhein-Flugzeugbau GmbH, Krefeld, builds the well-known RW 3 *Multoplane* sports and training aircraft, and will probably show the new RF1 six-seat STOL touring aircraft at Paris.

Sell-Haus- und Küchentechnik GmbH, Herborn/Hessen (subsidiary of Burger Eisenwerke AG), specialist in aircraft galleys, will exhibit the galley which it has developed for Lufthansa's Boeing 720s (with JUNO oven for thawing deep-frozen meals and grilling) on the BDLI stand.

The Siemens-Schuckertwerke AG SHF 20d-1 high-intensity runway light.

A model of the SIAT 222 sports and touring aircraft is being exhibited by Siebelwerke ATG, of Donauwörth, at the Paris Air Show.

Siebel-Werke ATG, GmbH/Waggon- und Maschinenbau GmbH, Donauwörth (both companies are to be considered as a single firm according to trade registers. Capital DM 4.35 million = $1.09 million, of which DM 0.75 million belong to Siebel and DM 3.6 million to Waggon- und Maschinenbau. Majority holder is Eisenwerkgesellschaft Maximilianshütte AG of the Flick Group, and about one third is held by Bölkow-Entwicklungen KG). Now that production of parts for the *Noratlas* has been phased out, Siebel-Werke is manufacturing assemblies for the F-104G programme. The SIAT 222 sports and touring aircraft is being developed as a private venture. This four-seater, which is of all-metal monocoque construction, has an all-up weight of 2,200 lb and a cruising speed of 179 m.p.h. and will probably be exhibited on the Bölkow stand at Paris.



German armed forces Sikorsky helicopters being overhauled at the Henschel-Flugzeugwerke Kassel facility.

Siemens-Schuckertwerke AG, Berlin/Erlangen (capital DM 300 million = $75 million, 100% owned by Siemens & Halske AG, Berlin and Munich). The Siemens concern ranks with Daimler-Benz, Krupp, Mannesmann and the Volkswagen company among the major firms in German industry. Only a small sector of Siemens-Schuckertwerke's activities will, however, be represented at Paris, including a variety of high-intensity approach lights (intensity up to 500,000 candles); high-intensity runway and threshold lighting; taxiway lights with blue rotating refractors, danger lights and searchlights. Siemens & Halske (communications) will not be represented in Paris.

Techno-Chemie Kessler & Co. GmbH, Frankfurt/Main, will be exhibiting hoses, couplings, Vacuflex suction hoses etc. on the BDLI stand.

Weser Flugzeugbau GmbH, Bremen (capital DM 7 million, one of the main concerns of Friedrich Krupp, Essen; 43% owned by United Aircraft Corporation; facilities near Bremen and at Lemwerder). The Lemwerder works maintain and repair Air Force Republic F-84Fs and RF-84Fs and Nord *Noratlas* aircraft, overhaul aircraft engines and take aircraft out of "mothballs." The Development and Experimental Department is project leader for the Franco-German *Transall C.160*. Further development work includes the Weser/Sikorsky S-64 crane helicopter; projects for a light helicopter and a hydrofoil boat; research on STOL and VTOL aircraft, means of increasing wing lift, and new engine configurations.

Einswarden works: manufacture of *Noratlas* parts is nearing completion; overhaul of helicopters; construction of fuselage centre sections for Arge Nord F-104Gs; production of fuselage centre section for the *Transall C.160* and final assembly of a prototype; construction of two DFS 582 high-altitude sailplanes (Pratt & Whitney JT12s); construction of containers, ship's superstructures etc.

Varel works: construction of equipment, tools and gauges of all kinds; machining of aircraft parts; construction of machine components and machines.

Equipment, models and components will give a survey of this programme at the Paris Air Show.

Zentroguss GmbH, Hirzenhain/Oberhessen (part of the Flick Group). Produces fine steel castings under licence to Gebr. Sulzer AG, Winterthur, Switzerland and supplies parts built of high-temperature alloys for engines and compressors, such as turbine blades, turbine wheels for superchargers etc. Production samples will be on view in Paris. ←

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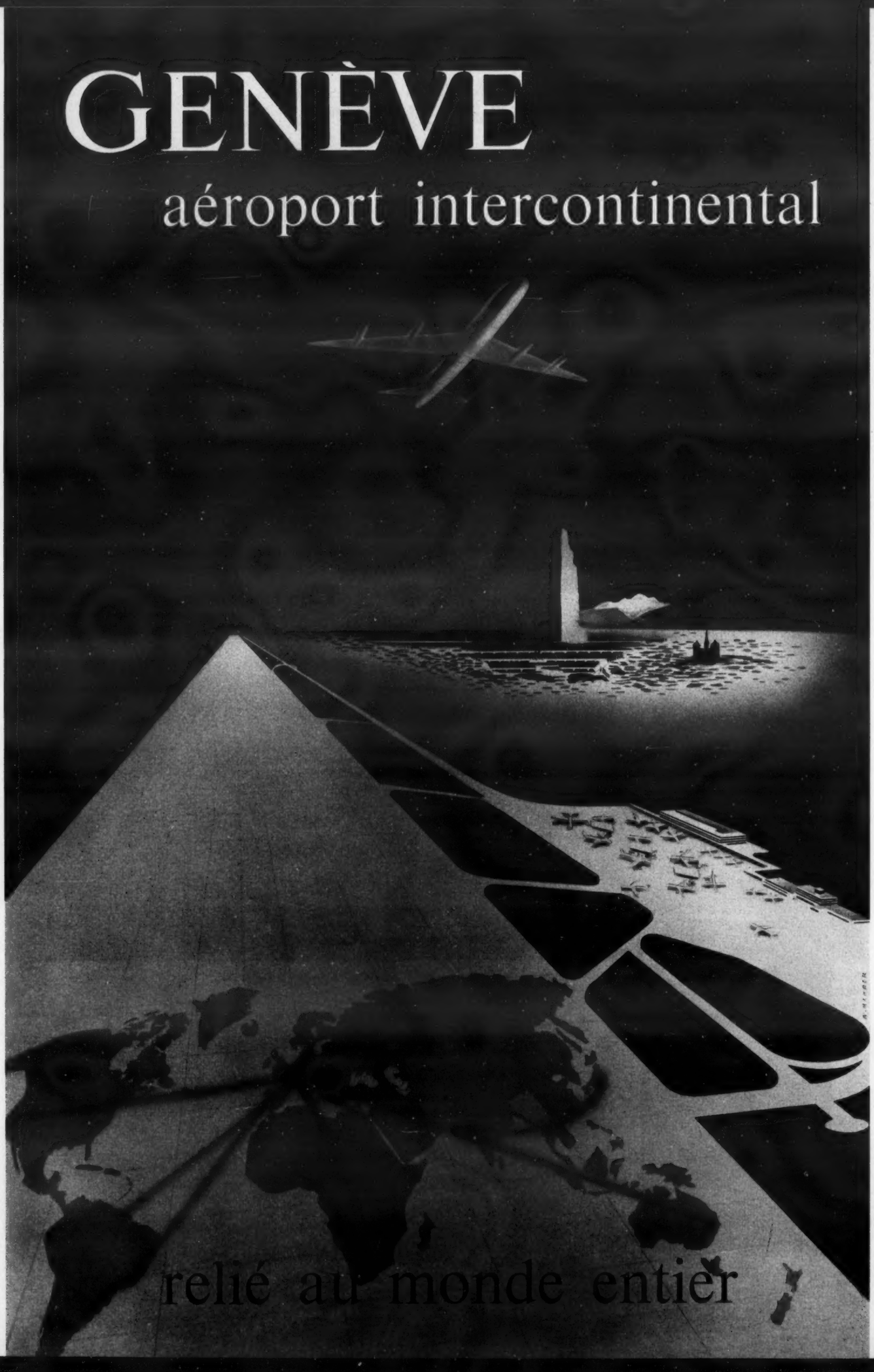
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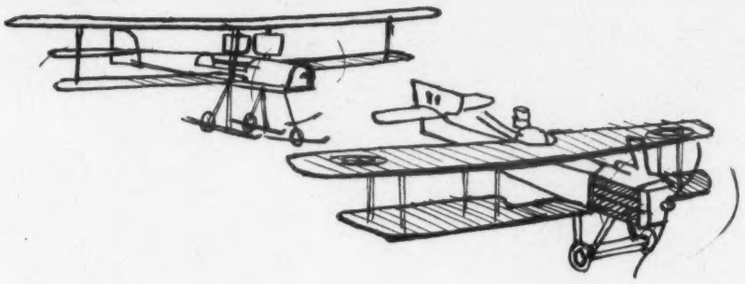

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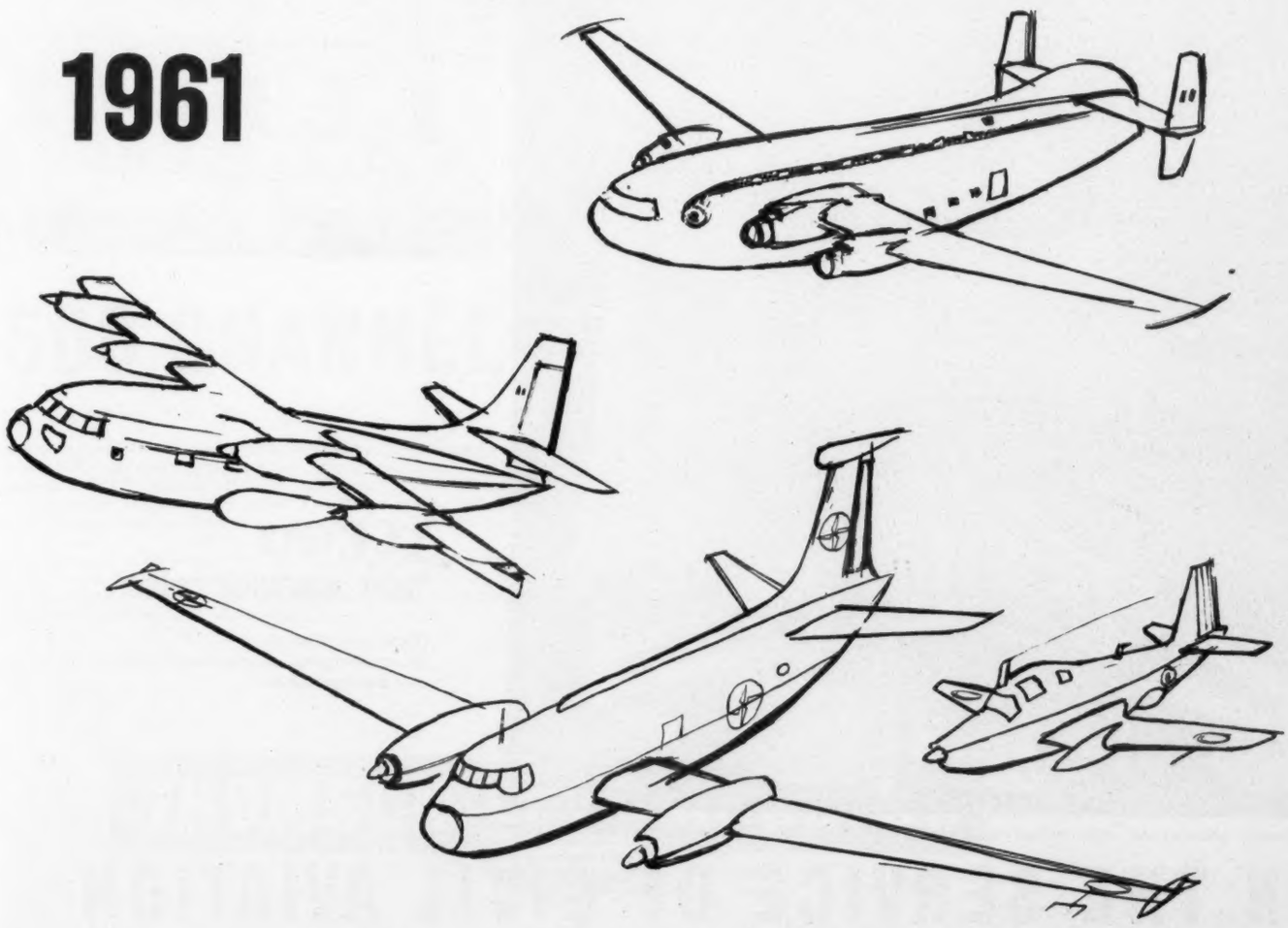

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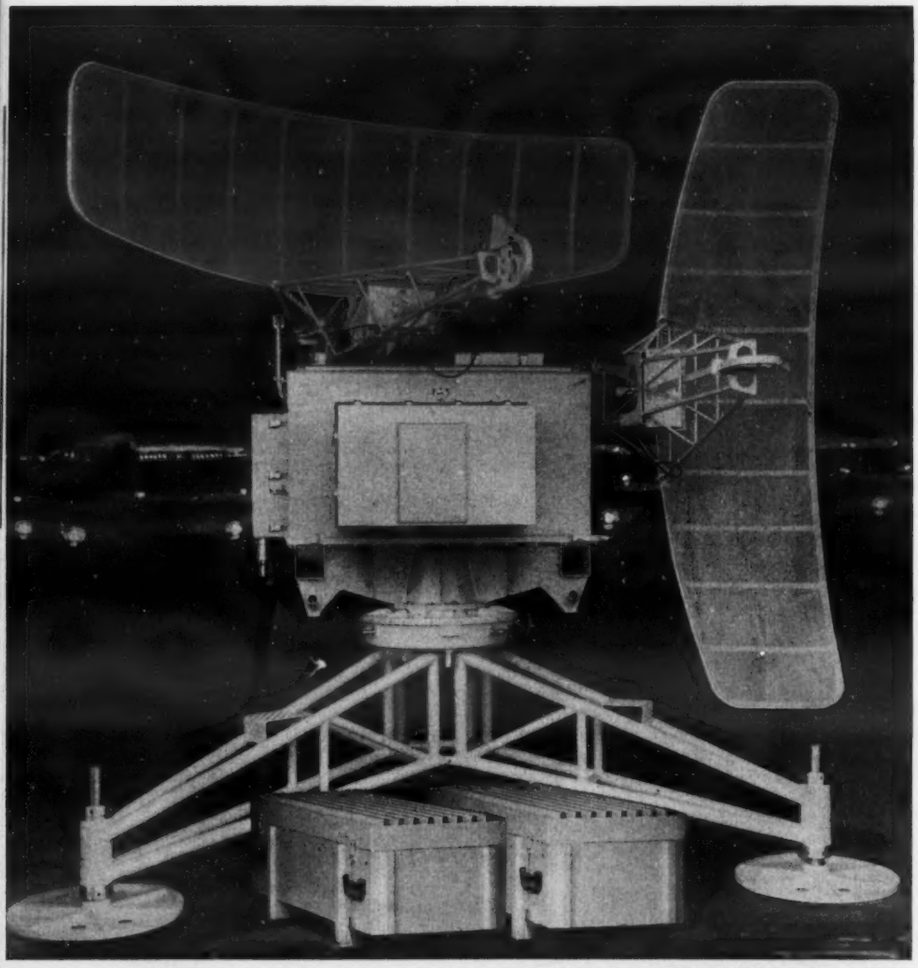

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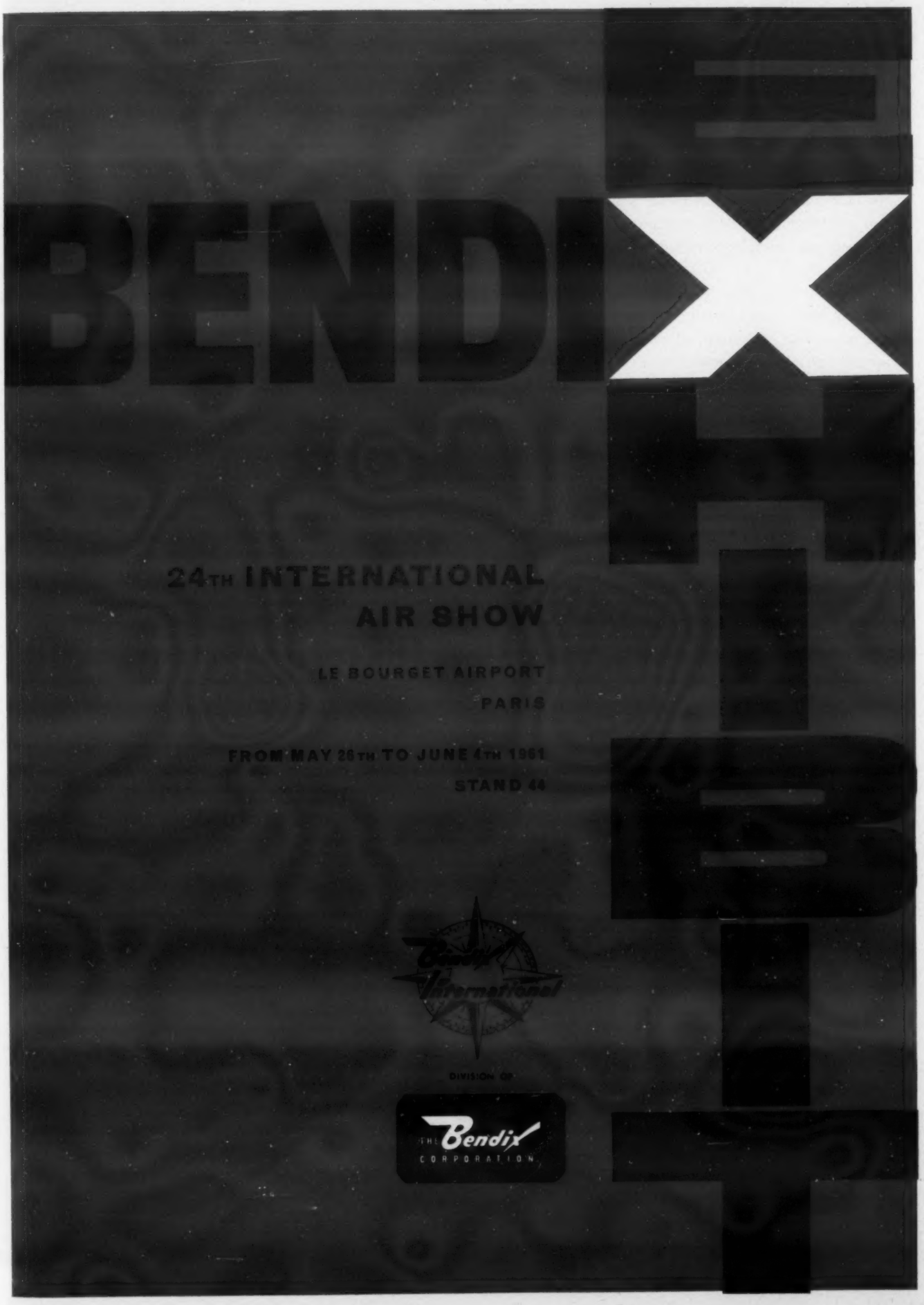
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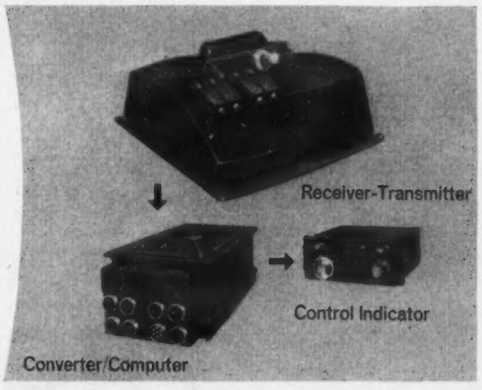

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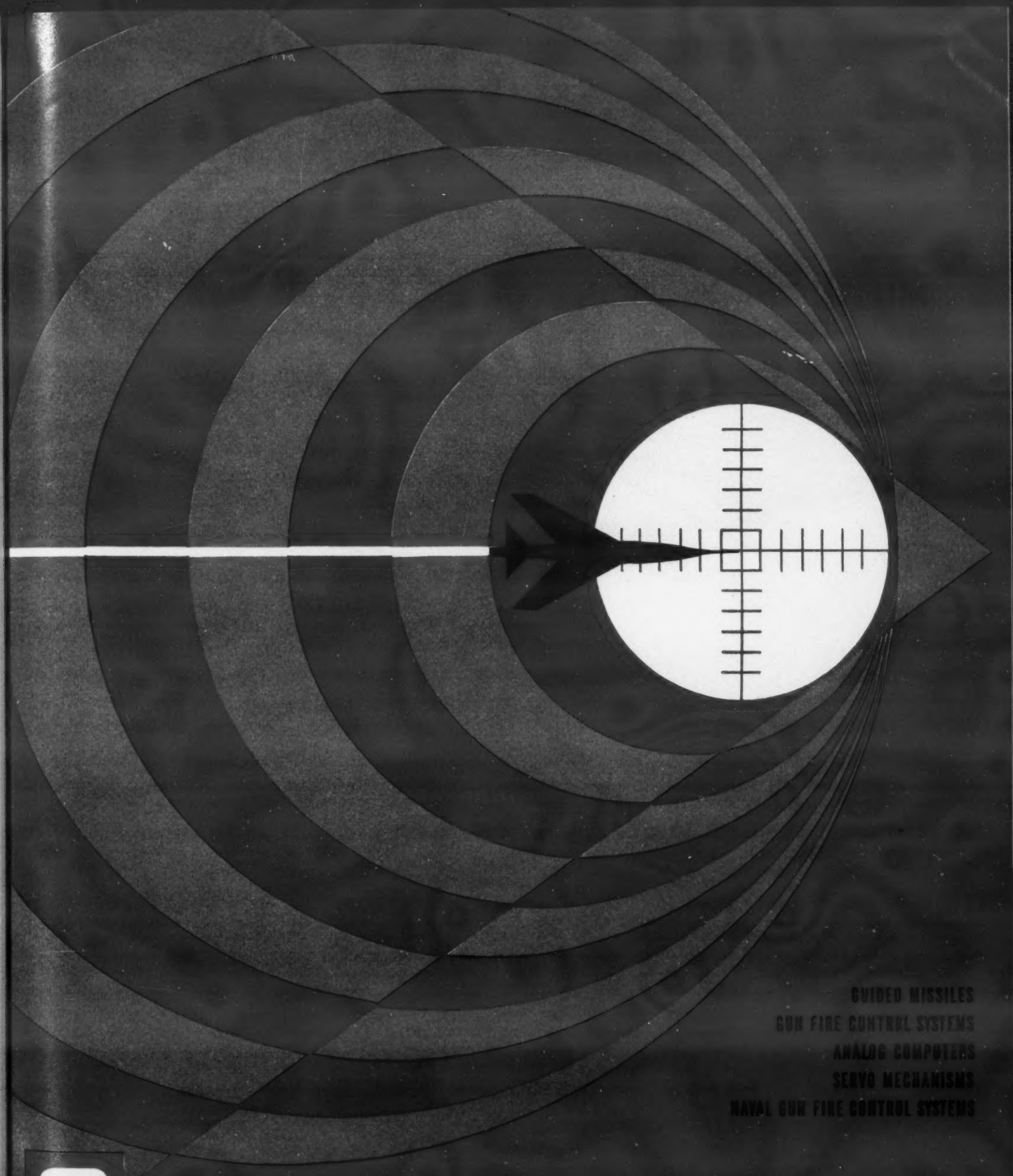

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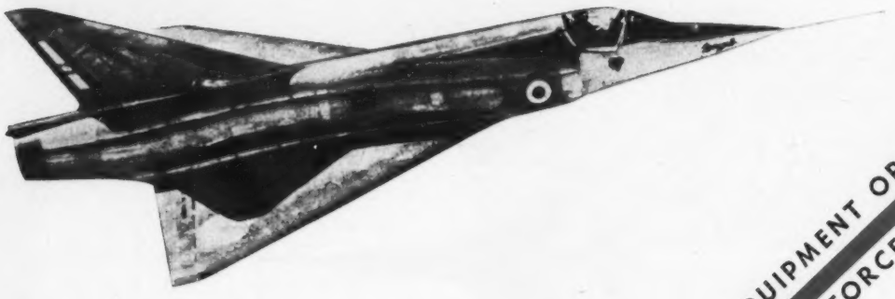

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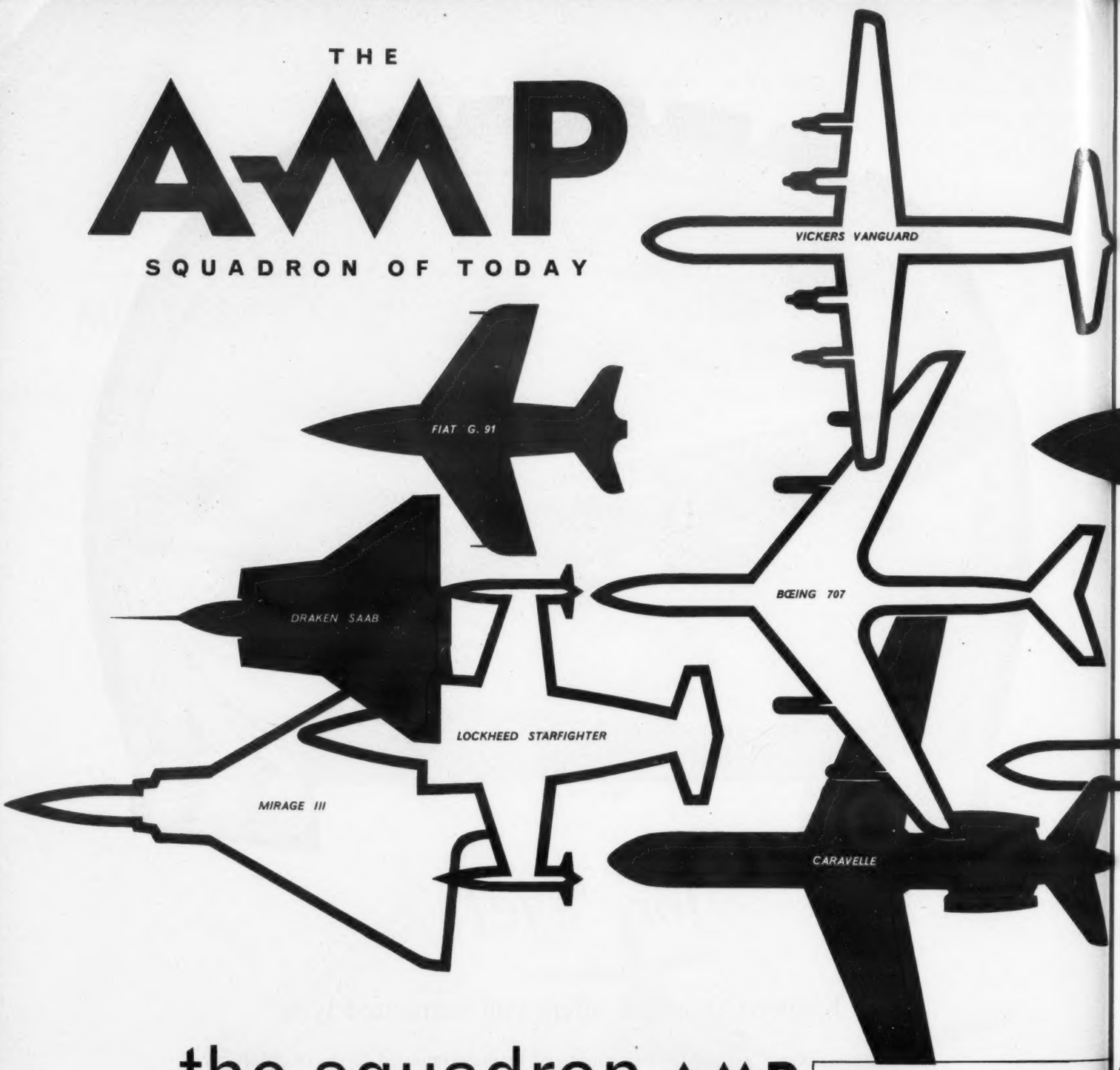

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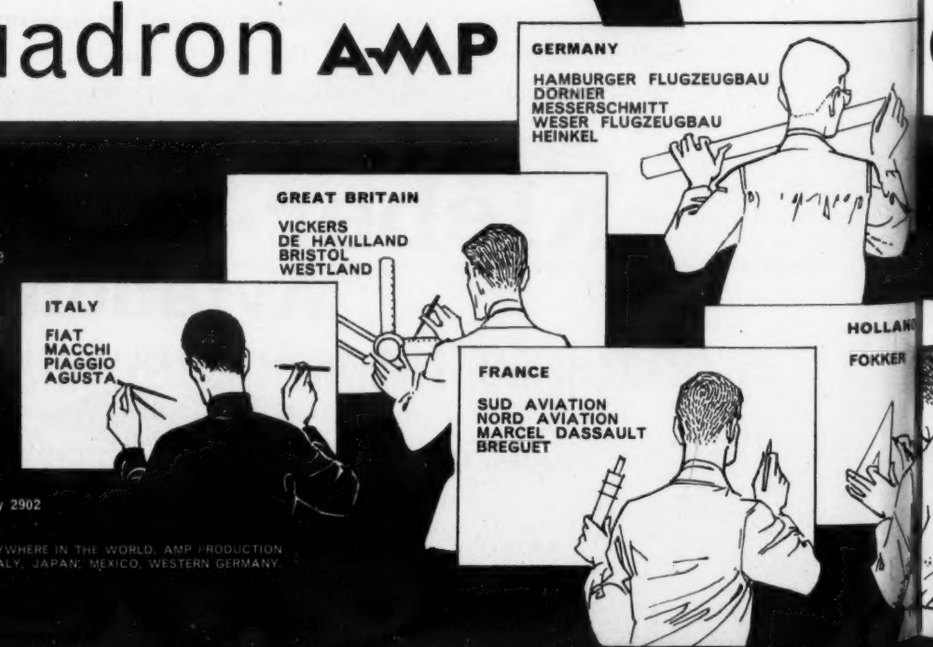

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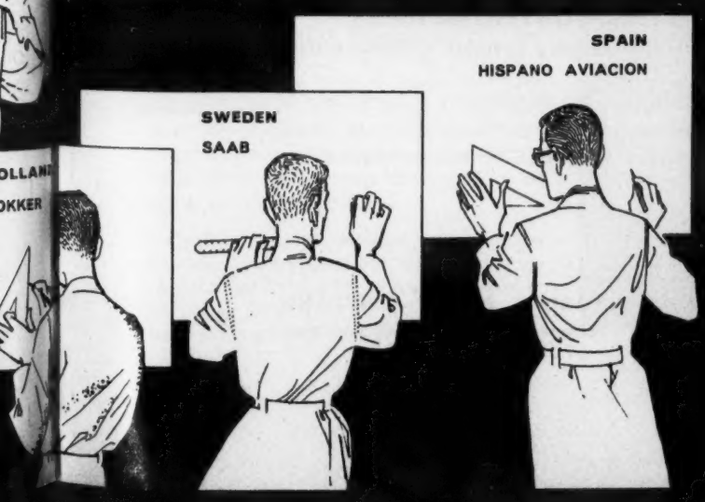

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FEATURES OF THE EXHIBITION

XXI Engineering exhibition
VIII European plastics salon
XIII Exhibition of cinematography, photography and optics
XI Exhibition of agricultural machinery
I Display of electrical household appliances, radio and television
XIII Display of technical, scientific and other periodicals
IV Exhibition and competititon—inventions and industrial progress
I European metallurgy and foundry salon

CONCURRENT EVENTS

XIII International Cinematographic Congress (Sept. 24th-27th)
XIII International Plastics Congress (Sept. 28th-30th)
I International Congress on Automation (Sept. 24th-26th)
ATA-ATI-AIDA Congress (Sept. 27th-29th)
VI Assofond Foundry Convention (Oct. 1st-4th)

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Telephone: Ilford 3040 Telex 21366 Overseas Telegrams: Plessinter Telex Ilford.

• The Netherlands

Following the contract concluded between the two concerns in March 1960, it is hardly surprising that, at the forthcoming Paris Air Show, Fokker-Werke will be sharing a stand with Republic Aviation. As is well known, the contract in question provides for close cooperation in the field of aircraft and guided missile construction. At the same time Republic acquired a third of Fokker's share capital. Doubtless part of the exhibits will accordingly relate to joint projects, and it would not be unexpected to find the two companies using the Paris Air Show as an occasion for making public designs for a V/STOL combat aircraft. There has also often been talk in the last few months of joint development of a STOL transport.

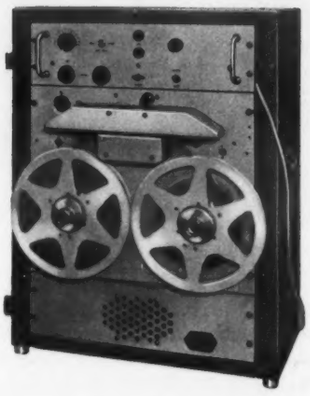
Over and above this, Fokker will illustrate its participation in European joint production programmes. Fokker belongs to the "North" Group, which is to build 350 aircraft under the F-104G programme, and in this connection Fokker is responsible for final assembly and flight testing. Fokker is also delivering the central wing section, the engine nacelles and some other small components for the Breguet *Atlantic* NATO patrol aircraft.

It goes without saying that Fokker will also be including in its exhibits its most successful post-war development, the F-27, and this aircraft will probably also take part in the flying display. As we go to press, Fokker has 91 of these aircraft on its order book, in addition to which come the 82 built by Fairchild in the USA under licence. A few weeks ago, details of a lengthened fuselage version for 52 passengers became known; this machine, equipped with two Rolls-Royce *Dart RDa Mk. 528* turboprops, is said to carry 10,400 lb payload for 940 n.m. Fokker also offers an all-cargo adaptation and a "Combiplane" version for combined passenger-freight work. Models of this, and perhaps of other too, will be on show.

Fokker can certainly face the next few years with confidence, and the recently proposed doubling of the share capital to Hfl 7,300,000 speaks for itself.

The industrial products department of Fokker, with its own stand, will exhibit the FK 400 metal forming machine with new tool sets, as well as the "Piccolo"—a smaller machine of similar construction. Also on view will be a patented flanging machine for hot and cold jointing of metal parts, the latest model of the Fokker bond tester for non-destructive testing of metal joints, and a new development, the Fokker-Achard folding press which, by high precision setting of press and bed, avoids the necessity of finishing the metal pressings.

Hollandse Signaalapparaten has decided not to take its own stand but will all the same be represented by the fire control equipment which it has developed for the Short *Seacat* surface-to-air missile. It will be remembered that, like Philips, this firm is participating in the European production programme for the 104G and will build parts of the NASARR navigation and fire control equipment.



This portable playback unit belongs to the 7497 and 7494 magnetic tape recorders with 6 and 15 tracks respectively, manufactured by the Ateliers de Constructions Electriques de Charleroi.

• Belgium

Although the present economic situation forces the Belgian Government to make economies in its budget, this should have no immediate effects on the activity of the aircraft industry. Avions Fairey S.A. and SABCA are participating in the European production programme for 194 Lockheed F-104Gs (75 of which are destined for the Belgian forces). The Fabrique Nationale d'Armes de Guerre is, with Fiat and BMW, a main contractor for the manufacture of the General Electric J-79 engines, while ACEC (Autopilot), Bell Telephone Manufacturing Co. (PHI, flight data computer, inertial guidance), OIP (optical equipment) and MBLE (fire control equipment) are all to supply essential parts of the aircraft's equipment.

On the **Avions Fairey S.A.** stand will be seen a model of its plant at Gosselies, photographs of the equipment installed there, also fuel and oil filters (produced under licence from Aircraft Porous Media Inc., USA) and oil reservoirs and coolers (under licence from United Aircraft Products Inc., USA).

SABCA intends to show the manifold production facilities of its plant, with its modern equipment, especially in the fields of precision engineering, electronics, and hydraulics. SABCA is supplying components for Sud-Aviation's *Caravelle* and the NATO Fiat G.91 ground attack aircraft, is doing overhaul and repair work for the account of the Belgian, French, Canadian and USA governments (F-84F, U1A, L-20, CF-100, H-34A, T-33A, and *Hunter*) and is participating in the European production programmes for the F-104G, *Hawk* and *Atlantic*.

The Fabrique Nationale d'Armes de Guerre, the State-owned undertaking, which is also a member of the GEBECOMA (Groupement Belge des Constructeurs de Matériel Aéronautique), will exhibit engine parts, which are being produced on a large scale under licence from Rolls-Royce (compressor impeller wheel for the *Derwent* turbojet, low and high pressure turbine and tail pipes for the *Avon 100,* various components of the *Avon 203*) as well as photographs of the

With the *Friendship* F-27 Fokker returned after World War II to its proud tradition in commercial aircraft. So far orders have been placed with Fokker for 91 aircraft of this type, including 70 for service with airlines. Fairchild has obtained licence construction rights and sold 82 machines.

Czechoslovakia has booked orders for this 5-seat *Morava* L.200 executive aircraft from England, Poland, Spain and Hungary and Western Germany, as well as an order for 120 aircraft from the USSR. The L.200A, a further development fitted with two M-337 6-cylinder in-line engines with high altitude superchargers, each 210 b.h.p., has a maximum speed in excess of 180 m.p.h. at 6,500 ft.

Avon, of the General Electric J79 (to be produced by the Fabrique Nationale under the F-104G programme), of a Bendix injection pump and of engines for which the Fabrique Nationale has maintenance and overhaul contracts, namely Orenda and Turboméca. This undertaking is also participating in the *Atlantic* and *Hawk* programmes.

Stampe & Renard should be showing its *Monitor* and SV4 aircraft, at least in picture form.

It goes without saying that the **Ateliers de Constructions Electriques de Charleroi** (ACEC) will also have various products on view. The items on the development and production programme of this concern include, for example, industrial television systems, analogue computers, LOGACEC units, sequential circuits and code converters, automatic control systems for roller conveyors, pulse generators for teleprinters, and multi-track magnetic tape recorders.

• Sweden

As already reported, Sweden will be represented at this year's Paris Air Show by SAAB and Svenska Flygmotor AG only. **Svenska Aeroplan Aktiebolaget** (SAAB) will be presenting a special feature on its stand: for the first time, it will show to a wide public the model of the Saab 105. This aircraft is offered in two versions, as a military and civil trainer and as a fast communications or executive aircraft. A few weeks ago, it became known that both turbojets of the Saab 105 were in fact a new development by the French concern, Turboméca S.A., namely two by-pass engines.

A great success was recorded by SAAB's electronics division a few months ago in obtaining an order from the French Government for the delivery of the toss bombing computer for the GAMD *Etendard* naval fighter-bomber. Besides this, SAAB will exhibit the FH5 autopilot developed for the SAAB 35B and a new type of automatic pilot for air-to-ground (Robot 304) and air-to-air missiles. The BT13 hit indicator for gunnery training is also to be shown, likewise electronic test equipment for industrial purposes.

Svenska Flygmotor AB is concentrating its research and development effort more and more on engines for high supersonic speed, and will be putting on show the RR2 ramjet turbine engine and the V3 liquid-propellant rocket engine. The RB-322 drone, equipped with two RR2s, will be exhibited; this was originally conceived as a surface-to-air missile and is now used as a "flying test rig" for ramjet engines, its speed range is Mach 2 to 3, and it has a ceiling of over 12½ mi. Finally, mention should also be made of the model of a wind tunnel for variable Mach numbers (1.3—5).

A squadron of the first wing of the Swedish Air Force to be equipped with the SAAB J35 *Draken*.

• Switzerland

The **Pilatus Aircraft Works,** of Stans, on the Lake of Lucerne, will be demonstrating the *Porter* at Le Bourget. This six- to eight-seat STOL aircraft, which has won international renown for its performance in mountain areas — especially in Himalayas — is offered with various kinds of undercarriage: wheels, skis, floats, or combination undercarriage with wheels and skis. Powered by a 340 h.p. Lycoming GSO-480 horizontally opposed engine, the *Porter* has reached an altitude of 18,250 ft at an all-up weight of 3,300 lb and an altitude of 16,050 ft at its maximum gross weight of 3,960 lb. A new version, powered by the Turboméca *Astazou II* propeller turbine (take-off rating 530 s. h. p.), has recently begun flight tests, and Pilatus is also expected to show this aircraft at Paris.

• Czechoslovakia

In the field of sports and tourist aircraft, Czechoslovakia has continued to obtain considerable export orders, including orders from Western countries, through the State Foreign Trading Organization **Omnipol.** It is probable that the CSR will make the 5-seat *Morava* L.200 tourist aircraft the centre of its sales effort. The multi-purpose L-60 *Brigadyr*, which has also been sold in large numbers, as well as the L-40 *Meta Sokol*, a four-seat training and sports aircraft with an M 233 air-cooled 4 cylinder in-line engine of 140 h.p. (with supercharger) also require mention. The *Aero 145*, equipped with two engines of the same type, should have good prospects of repeating the export successes of its predecessor, the *Super Aero*. The youngest member of a famous family is the 2-seat Z-326 *Trenermaster*, the single seat version of which (the Z-326A *Akrobat*) was built specially for aerobatics. The most recent new development is the 5-seat HC-3 helicopter, three prototypes of which are currently undergoing flight tests. Czechoslovakia is also offering instrumentation for aircraft, test equipment, and airport lights.

• Poland

It is not known at time of going to press exactly what products will be in the sample case which **Motoimport,** the Polish State Export Organization, will be taking to Paris. It is however to be assumed that the PZL-101 *Gawron* (multi-purpose version and special agricultural version) and the PZL-102B *Kos* touring aircraft will be exhibited at the Salon and entered in the air display. ←→

For many years Interavia *has been a forum for technical and economic questions concerned with the air freight business, which has recently been taking on a new aspect since the introduction of turbine-powered aircraft. While for the time being both military and civil aviation are concerned primarily with turboprop aircraft, a substantial USAF order for a large jet transport has opened up a whole range of new possibilities—possibilities from which the civil air freight business is certain to benefit in the long run.* *Editors*

New Aspects of Air Freight

The most significant developments in all-cargo operations in the last year can be summarized as:

- conversion of some 75 late-model piston-engine airplanes to cargo configurations;
- introduction of the Armstrong Whitworth *Argosy* into civil operations;
- airline planning for introduction, in 1961, of the Canadair CL-44 turboprop freighter into U.S. domestic and North Atlantic service;
- extensive planning for use of mechanization, not only for terminal handling, but for loading and unloading the airplanes as well;
- a joint United States Air Force and Federal Aviation Agency announcement of an Air Force program for development of an all-cargo jet aircraft, designed to meet civil standards but fulfil the needs of both the military and commercial carriers.

For the last development, comprehensive specifications (SOR 182) were therefore drawn up for a heavy transport aircraft (150 tons) to be powered by four turbofan engines, which could carry a 50,000 lb payload over intercontinental distances and have direct operating costs of less then 5 cents per ton-mile. All the major American transport aircraft manufacturers submitted bids, and in mid-March, 1961 the U.S. Government announced its decision: the Lockheed Aircraft Corp. Georgia Division (as main contractor) was to cooperate with other companies in developing the jet transport, of which over 100 were to be built. Destined for the U.S. Military Air Transport Service, the transport was given the USAF designation C-141. Official information on weights and performance had not yet been issued as these lines went to print.

As the drawing shows, the C-141 is a high-wing aircraft, with swept wings, rear loading door and high horizontal tailplane, whose freight hold will probably be 9 ft high, 10 ft wide and 70 ft long. The entire transport system, including ground support equipment, has received the designation SS-476L (Support System 476 Logistic). The C-141 is being designed to meet both USAF and FAA specifications. As type certification tests will be carried out under CAR regulations, there is no reason why the aircraft should not be ultimately used as a civil transport, especially as it is designed to take off from 6,000 ft runways at maximum take-off weight.

*

All of this current activity warrants a review of existing philosophies on freighter aircraft and the various materials handling and documentation techniques which are an integral part of the economics of air cargo. It is the purpose of this article, therefore, to determine if developments to date have deviated from the optimum path and, if so, what must be done to "correct for drift."

In order to assist in this analysis, the following points will be considered:

- airplane size and configuration;
- payload/volume, or density, requirements;
- access for loading, i.e., number and types of cargo openings;
- the development of satisfactory loading aids and terminal design.

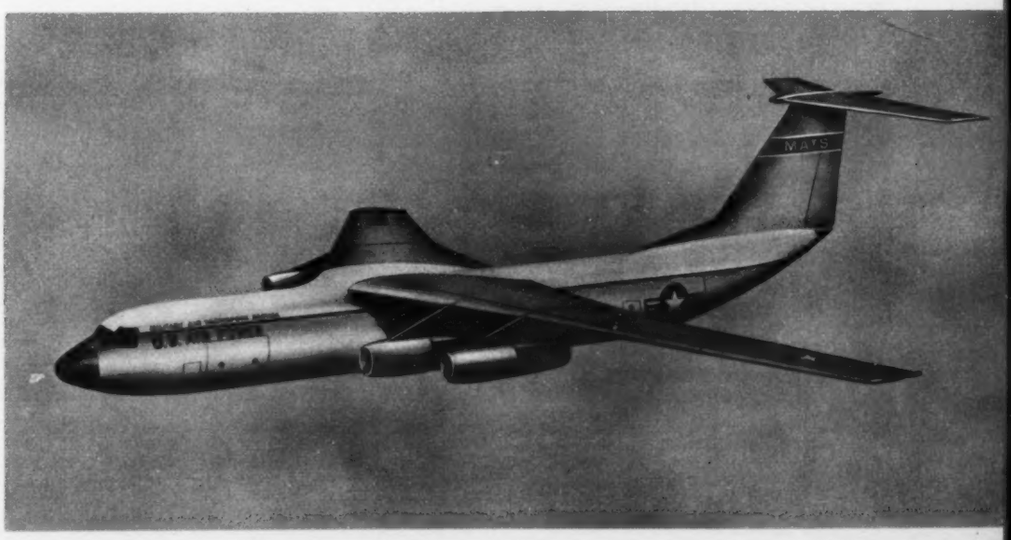
Airplane size and configuration

Some years ago the belief was prevalent that the economics of an airplane always improved with increase in size. One of the arguments put forward to substantiate this was that a large airplane needs no more crew or electronic equipment than a smaller one; therefore, the fact that more payload could be carried per crew member (or per pound of electronic gear) automatically ensured a lower operating cost per unit of payload carried.

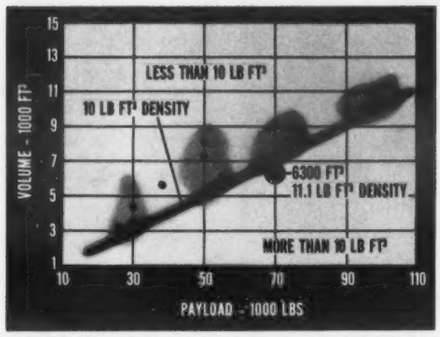
This argument neglects a number of important factors, such as:

1. The production cost per unit of weight of airplane and engine tends to decrease with an increase in the production quantity, and
2. the investment in spares, as a percentage of airplane initial cost, decreases with an increase in the number of aircraft in the fleet.

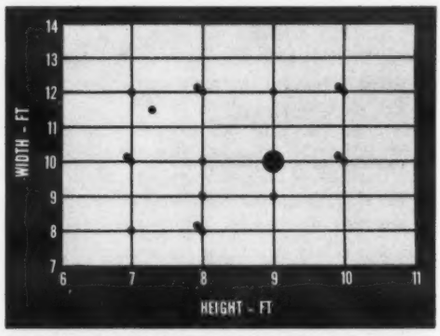
The Lockheed C-141 large capacity transporter, designed to meet the USAF SOR 182 requirement, will carry 50000 pounds at a cruising speed of more than 400 knots over intercontinental distances.



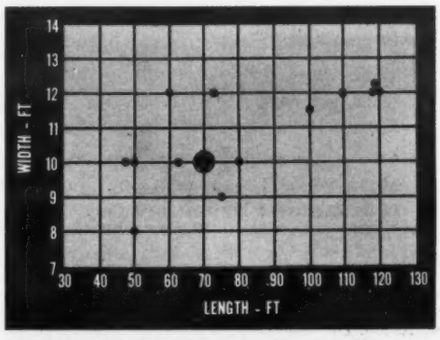
Results of an FAA questionnaire about the characteristics of a modern all-cargo transporter



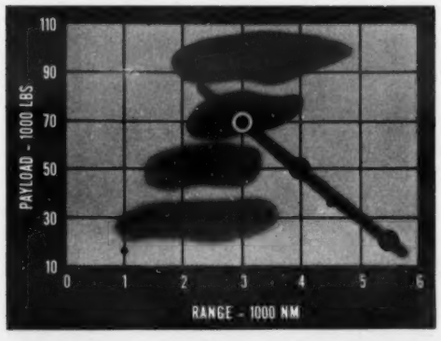
Required volume of cargo compartment (in 1,000 cu.ft.) versus payload (in 1,000 lb). The upward line represents an average load density of 10 lb per cu.ft. The USAF based its specification on a cargo density of 11.1 lb per cu.ft.



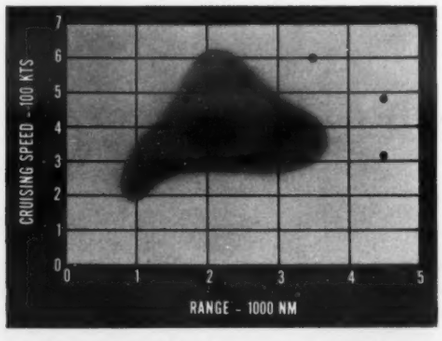
The wishes (indicated by small dots) of some of the airlines consulted by the FAA in respect of the cross section of the cargo compartment. Width versus height is shown. Again the heavy black spot marks the USAF requirement.



As to the length of the cargo compartment, great differences emerged in the desires of the airlines. In this graph length is shown against width, and the USAF's length requirement of 70 ft looks on the conservative side.



Ideas about transport performance, i.e. range (in 1,000 n.m.) versus payload (in 1,000 lb), vary widely too. But the average of the civil operators' requirements lies on the curve laid down by the USAF specification, namely 4,000 n.m. at 50,000 lb payload and 5,500 n.m. at 20,000 lb payload.



Cruising speed (in 100 knots) versus range (in 1,000 n.m.). Originally the USAF did not lay down a definite speed; but for the C-141 since ordered, the cruising speed lies at over 400 knots.

When the foregoing points are taken into consideration, we find that "biggest" does not necessarily mean "best and most economical."

Until such time as the manufacturers *and* the commercial carriers can agree on requirements, both as to airplane types and to production quantities, the commercial all-cargo aircraft seems destined to be a derivative of some other type of airplane.

In the past, requirements for civil freighters were so limited that the only logical solution was to adapt a certificated passenger vehicle for cargo use. This immediately raised a number of problems, in that the optimum passenger configuration was rather poor for freight from the standpoint of:

1. fuselage cross section;
2. floor height;
3. fuselage length considerations, in terms of landing angle and weight and balance problems;
4. size and location of loading doors.

The most objective approach to this question seems to have been taken by the Unites States Air Force, when it recognized as long ago as 1950 that an airfreighter is just another transportation tool and should therefore be capable of carrying the largest items which can normally be carried on the highways. These highway limitations vary somewhat, but in general the maximum widths are about 8 ft 2 in. in Britain and most major roads on the European continent, and 8 ft in the United States.

Recognizing this fact, the U.S. Air Force has procured a small number of airplanes for "outsize" cargo, but for the bulk of its transport work it requires a freighter with a fuselage opening of ten feet wide by nine feet high.

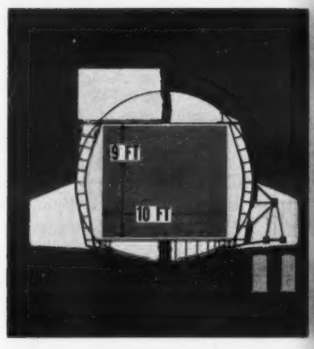
This requirement of the Air Force, coupled with the 1960 requirement that the airplane meet civil certification standards, opens the way to production of a freighter in sufficient quantities for both civil and military use.

Relationship between payload weight and volume

Since 1958 there have been requests on the part of some carriers for a freighter which can carry its full payload when the "on-loaded" density of the cargo averages only six pounds per cubic foot. This requirement stems from the fact that many commodities, such as flowers, wearing apparel and also automobiles have a low ratio of weight to volume. But what of the built-in penalties caused by operating an airplane that for most of its life is carrying "too much sheet metal wrapped around too much air?"

A study of this was made on a family of airplanes, all of which had identical wings, powerplants, landing gear and gross weights, but had varying sizes of fuselage (similar to the B-50 versus the C-97).

The initial configuration studied was for a 50,000 lb maximum payload and a usuable volume of 6,250 cu.ft., or an on-loaded density of 8 lb/cu.ft. The final configuration was one with



a usuable volume of 6,350 cu.ft., which permitted an increase in payload to approximately 55,000 lb.

Of course, the final version was cheaper to operate, in terms of both cost per mile and cost per ton-mile. However, what would be the actual average payload that could be carried on a "lifetime" basis?

This answer required a statistical analysis of the nature of actual airline and military cargoes requiring more than two years, and resulted in a term called "equivalent load factor." By definition, the equivalent load factor is the relationship between the average payload per flight *for the life of the airplane* and the maximum payload capacity of the airplane, when this maximum payload is available *for each flight*.

The effect of the equivalent factor on attained payloads shows that the maximum payload, for otherwise 100% load factor conditions, is at average densities of between 10 and 11 lb/cu.ft. As for minimum direct operating costs, for otherwise 100% load factor conditions, these occur at average densities of between 11 and 12 lb/cu.ft.

Now, if probability of load factor variation is introduced into the probability of density variation, these optimum values of density will rise even higher and will for most types of operation tend to be between 13 and 14 lb/cu.ft. Acceptance of this situation implies recognition of the fact that some flights will be space-limited to less than full payload. Nevertheless, it is the long-span operation that must be considered when selecting the

optimum relationship between payload weight and volume.

Perhaps a comparison with other modes of transportation is in order at this point: some truckers in the United States use a density value of 22 lb/cu.ft., whereas for some marine transport a value of 30 lb/cu.ft. is considered normal.

Access for loading

Requirements for ease of access to the cargo compartment, particularly for unloading, is best illustrated by a review of the military requirements for air dropping of men and material. This does, in fact, represent the first extensive use of palletization.[1] Furthermore, in order to permit maximum use of standard ground conveyances, it has dictated the requirement of truck-bed-height loading.

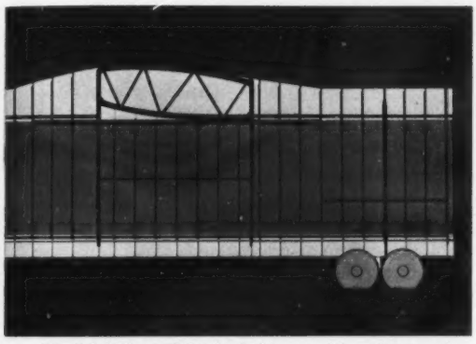
Heretofore, compliance with this air drop requirement has been costly in terms of airplane weight and drag penalties. Recent extensive study and wind tunnel testing have, however, confirmed the possibility of fairing onto a cylindrical fuselage an afterbody which has a cruise drag comparable with that of a conventional symmetrical aft-end. Although this configuration is compatible with a door and ramps system in that it opens to expose the full cargo cross section, the structural weight penalty to provide air drop capability is only 0.35%, and this can be eliminated in commercial versions.

Using military experience as a guide, the "ideal" mechanized loading system can be considered to have the following characteristics:

1. use of pre-loaded pallets (and/or unitized containers) which can be loaded onto trucks or vans for transport by road;
2. adaptation of these pallets (and/or containers) to an aircraft which permits straight-in loading and unloading through an opening the full width and height of the cargo compartment;
3. ability to carry items which, because of size, require bridging across two or more pallets;

[1] Pallets are platforms onto which freight is loaded before it is put into the aircraft; it is held in place by a net or removable walls. This method simplifies loading and shortens loading times.

Heavy loads and paratroops can be air-dropped through the aft loading doors. These can be opened in flight, the aft, normally vertical, pressure bulkhead moving downwards and serving as a dropping ramp. The C-141's landing gear is retracted into the front part of the fuselage and into ridge-like cowlings on the side of the central part of the fuselage.



The 9 ft high × 10 ft wide hold runs without interruption from the fuselage nose to the aft loading doors. To retain uniform dimensions along the whole length of the interior, the wing spar has been placed above the cargo compartment.

The Lockheed C-141 Jet Transport

The high-wing monoplane illustrated below won the United States Air Force design competition for a large-capacity intercontinental cargo jet (as per specification SOR 182). The flight performance of this Lockheed transport, designated Support System 476 Logistic (SS-476L), makes it easily capable of crossing the Atlantic or Pacific with substantial payloads, yet at the same time the possibility of operation from relatively short runways is retained.

The fuselage is so close to the ground that loading of the 70 ft long hold is carried out at the height of a normal platform, i.e. 4 ft to 4¼ ft above ground level. The wing position allows the four turbofan jets to be suspended on pylons under the wing, providing adequate ground clearance for the engines. Of special interest are the large doors of the stern opening, which can be opened so as to leave the entire 9 ft × 10 ft opening clear for air-dropping the load.

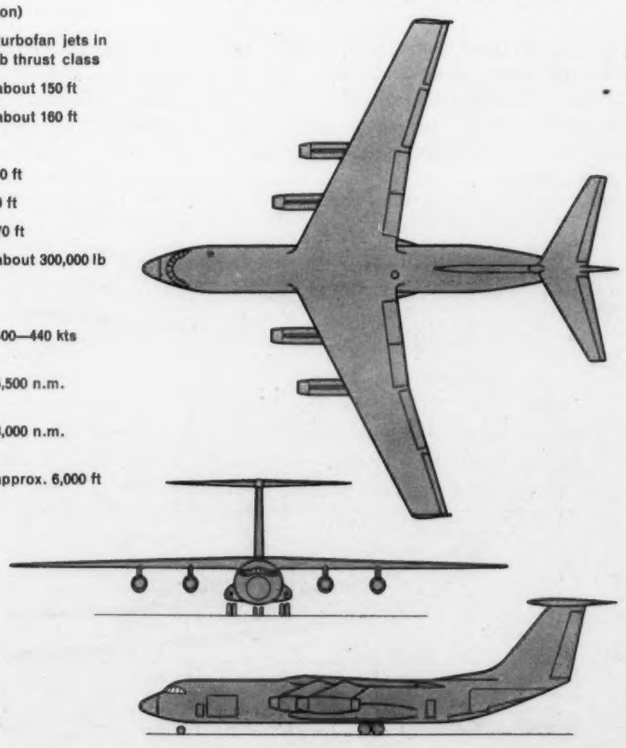
According to the official announcement by U.S. President Kennedy, in the Government competition for the contract Lockheed was substantially the lowest bidder and obtained the contract for the development and production programme, which covers a number of years. This programme is said to call for the construction of more than 100 aircraft; in any case, a good many C-141s should go into service with the Military Air Transport Service in 1964. It is already settled that Lockheed's Georgia Division will be responsible for prototype construction as well as for full-scale production, and it is expected that sub-contracts to be placed by Lockheed in the California area will amount to more than half the total value of the contract.

Technical Data

(from unconfirmed information)

Engines	4 Pratt & Whitney turbofan jets in the 23,000—24,000 lb thrust class
Overall length	about 150 ft
Span	about 160 ft
Dimensions of hold	
Minimum width	10 ft
Minimum height	9 ft
Length	70 ft
Take-off weight	about 300,000 lb
Flight Performance	
Cruising speed	400—440 kts
Range with 20,000 lb payload	5,500 n.m.
Range with 50,000 lb payload	3,000 n.m.
Runway length for take-off at max. weight	approx. 6,000 ft

Three-view drawing of the Lockheed C-141.



4. fastening of the loads to the pallets and subsequent latching of pallets (and/or containers) to the aircraft structure;
5. ability to completely unload the aircraft at en route as well as turnaround stops;
6. ability to rework the load outside the aircraft, including detaching and removing pallets or containers, and also rearranging their sequence (for reasons of weight and balance or for operational convenience).

Effect of loading time on utilization

Perhaps the most important characteristic in the development of aviation has been speed; another continuing trend is that of increase in payload capacity—though there are indications that this trend may be approaching a plateau, at least for the near future.

An analysis of the daily utilization capabilities of five representative hand-loaded freighters was made under the following conditions:
- loading at 20,000 pounds per hour;
- unloading at 40,000 pounds per hour;
- one half of maximum payload handled at en route stops;
- total route length of 2,000 statute miles between turnaround points.

In summary, the following gives 45 minutes turnaround time and 22.5 minutes en route stop time for each 10,000 lb payload capacity.

This analysis emphasizes the tremendous loss in utilization capability as payloads and cruising speeds increase. Further investigation as to the major source of difficulty highlights ground time (time for unloading, loading and refueling) as the principal area in which to concentrate, particularly for shorter stage-length operations.

With reductions of 50% and 75% in ground time the utilization capability can be increased by more than 30% and 50% respectively on stage lengths of approximately 500 statute miles.

Loading methods

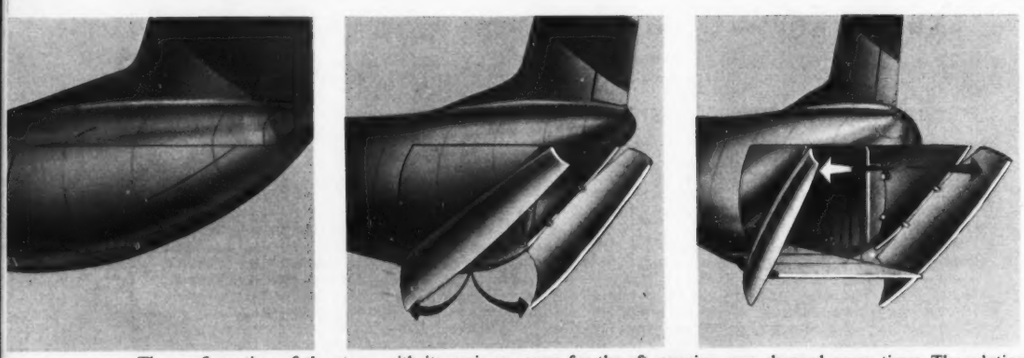
One of the previously stated characteristics of the "ideal" mechanized loading system is the ability to rework the payload of cargo outside the aircraft; this includes detachment and removal of pallets and containers, as well as rearranging their sequence. This can be accomplished readily if the loading area contains the following sets of roller conveyors:
- one "main-line" conveyor;
- one or more "secondary-line" conveyors;
- one transverse conveyor for each pallet station.

En route stop operation

At a typical en route stop the following manoeuvres might be carried out:
- off-loading of pallets 2 and 4 of a five-pallet train for delivery (or for rework and relocation to another freighter);
- on-loading of a piece of cargo of such a size that two pallets are required;
- for reasons of airplane balance, the onloaded cargo must be positioned near the airplane center of gravity.

Numerous full-scale tests have shown that this complete en route operation can be performed in approximately 20 minutes from the time unloading of the airplane begins until it is reloaded and ready to be dispatched. Even though only one full-opening door has been utilized, the savings in ground time are as much as 90% on larger airplanes. The desirability of having more than one end-loading door is therefore questionable, particularly when the effect of door weight, cost and drag on the airplane payload and economics are considered.

The airborne portion of the mechanized loading system must be capable of being accommodated at both high-volume, highly-mechanized terminals and at low-volume remote stops where there are limitations on the amount of capital invested for ground equipment.



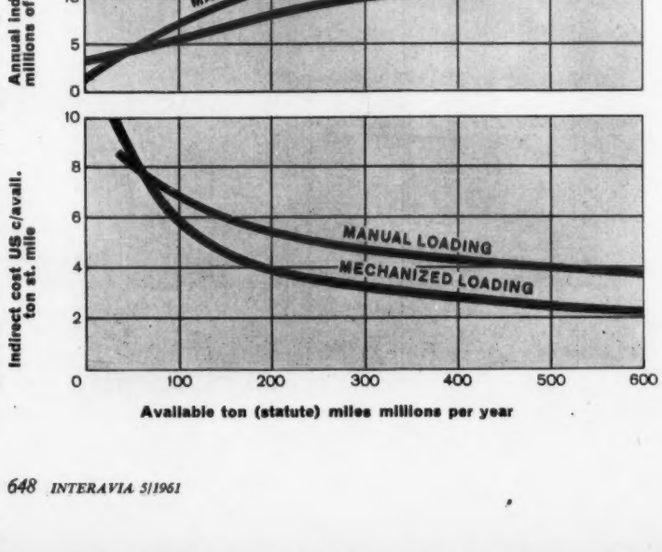
The configuration of the stern, with its various covers for the aft opening, was changed many times. The solution illustrated here is the one proposed at the first project stage, and was later abandoned. A rear pressure bulkhead to fold downwards and serve as loading or dropping ramp was, however, common to all the designs studied.

The standardized terminal

The airplane is but one link in an integrated air cargo system. Long-haul air freighters, connecting with short-haul aircraft and local trucks or vans, provide means for economical transport from shipper to receiver. The complete system includes cargo terminals, aircraft loading equipment and documentation, in addition to the airplane plus its airborne equipment. In general, the basic requirements of the air cargo portion can be considered as being:
- minimum aircraft ground time, to increase airplane utilization;
- rapid handling of cargo;
- minimum aircraft penalties, in terms of payload and volume;
- late "close-out" capability, to permit processing of last-minute shipments;
- minimum airport space;
- low cost, combined wirh improved service to the customer.

Another feature which is highly desirable is that the system be applicable immediately, but yet be flexible enough to meet the expanded requirements for the predicted era of all-cargo operations.

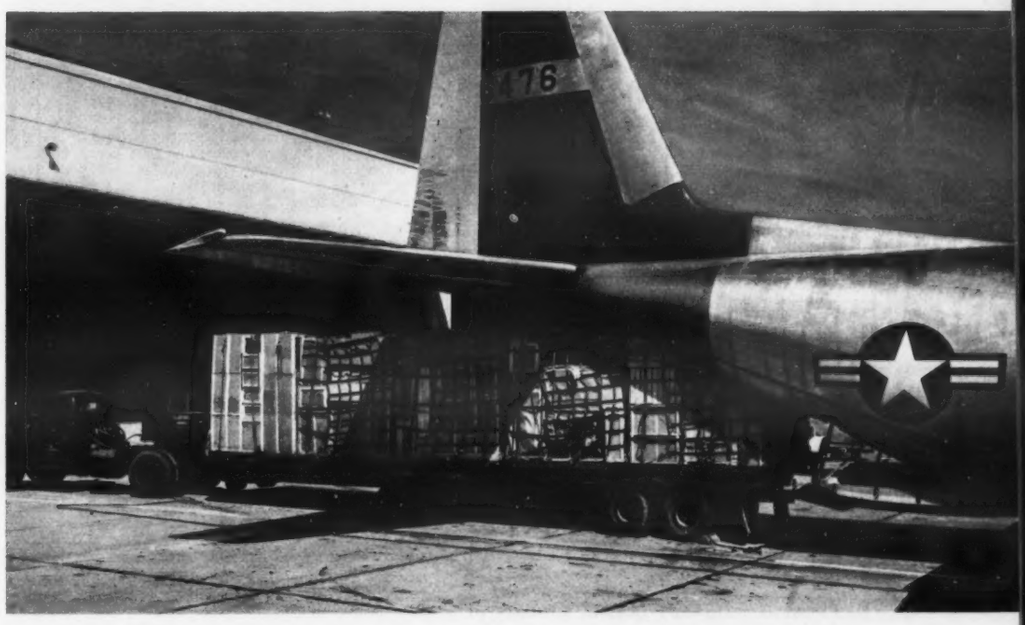
The key to the achievement of this aim is the standardization of terminals and of aircraft loading equipment, so that all type of air freighters can be accommodated. Initially, this will mean high-floor side-loaded aircraft, which have been converted from passenger use. As the newer turbine-powered freighters become operational, em-



The annual indirect costs of the C-141 in American domestic operation. This graph shows available ton-miles (in millions) versus annual indirect costs (in millions of dollars) and the indirect costs (in U.S. cents) per available ton-mile.

phasis will shift to end-loading configuration, both high- and low-floor, and nose- and tail-loaded. The third phase will see only end-loaded aircraft.

Surface freight transportation has met this problem by standardizing on the gauge of railroad tracks and also on the loading height of trucks. If, therefore, an air cargo system can be developed and accepted, employing a standard means of materials handling in the terminal and airplane, considerable progress will have been made.



A Lockheed C-130 turboprop transport taking cargo on board from a low loading trailer, the loading platform of which is level with the C-130's cargo compartment. The freight is preloaded on pallets and held by restraint nets.

Airborne equipment

Unitization or consolidation of loads is becoming more and more accepted as an economical means of decreasing loading time. But since there is as yet no recognized agreement on pallet sizes, initial standardization must be limited to the means of conveyance and of restraint of the pallets, both in the airplane and at the terminal.

One system now being favourably received in the airline industry is conceptually the same as a railroad network over which cars of varying size and capacity move on a standard gauge track. In this system, pallets or containers of different deck sizes move over a standard roller conveyor track, which can be used with all aircraft, regardless of type. Standardization is achieved by incorporating a shouldered flange or "dropped section" on each pallet, located below the lower surface of the pallet deck (see figure on last page of this article). On the larger pallets, above 83 inches minimum width, this dropped section is square, permitting positioning of the pallet and retention of guidance and restraint in four directions of pallet travel. Mobility is provided by rollers in the track, with vertical restraint for the airborne units being achieved by mating the pallet flanges with compatible flanges on the tracks installed in the aircraft.

Distance between the rails (the track "gauge") has been set as 80 in., because this has proven acceptable for every air freighter analyzed to date. Furthermore, this measurement is also a multiple of the 20 in. distance between floor tie-down rings, one of the few standardized features now incorporated in all cargo airplanes produced in the United States.

The basic cargo unit consists of the pallet as a base, and a restraint net or container sides which attach to standard fittings on the pallet. For shipment of the empty pallets, the container sides can be stacked on the pallets.

For loading end-loaded aircraft, the pallets can be quickly coupled to form a train, thereby facilitating loading of the complete airplane. Use of the dropped-section configuration permits selection of pallet deck sizes which are optimum for the types of aircraft being used. Meanwhile the common rail system provides for the interchange of pallets between aircraft types.

Pallet sizes which will fit this system are multiples of five inches, less two inches (the thickness of the stops between the pallets), with minimum length of 83 in. (if two-directional mobility is adequate) and minimum length *and* width of 83 in. (if four-directional mobility is desired).

Since rail gauge is the same in all aircraft, compatibility in a mixed fleet is readily achieved. This will provide the flexibility required during the transition period from piston-engine planes to turbine-powered freighters.

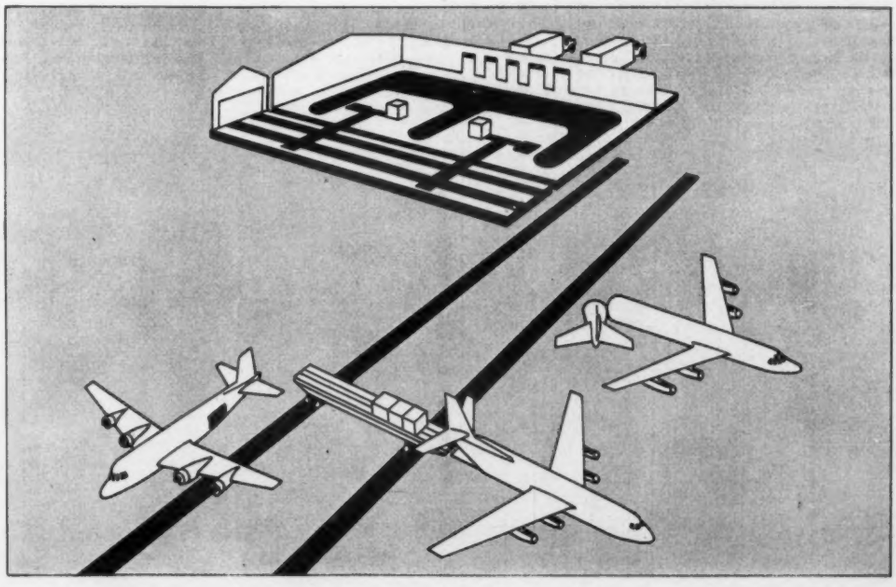
Many specialized types of containers can be fitted to the basic pallet, to meet requirements of aircraft configuration or commodity. Examples of the latter are livestock stalls or refrigerated containers.

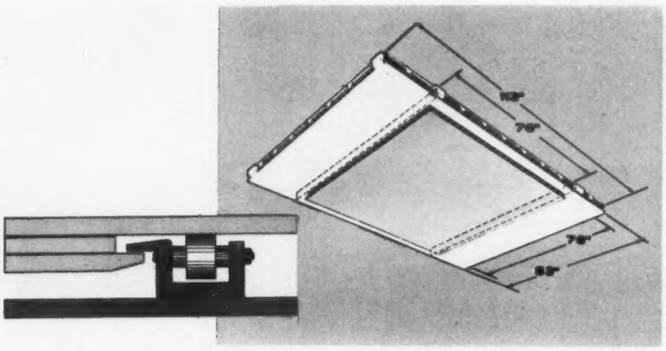
Terminals and their equipment

Space does not permit a detailed description of model freight terminals in the present article, but the accompanying figures will give readers a clear picture of how such terminals work.

Among the several types of mechanized terminal which were analyzed, one using a complete

The air cargo system of to-morrow is designed to give as much flexibility as possible, in order to meet the increased demands of future all-cargo traffic. Unitization of the terminal and ground installations is therefore indispensable, for only in this way is it possible to cope with all types of air freighters. To start with, the converted passenger aircraft with high floor and side loading door will be the main aircraft in question. Then, as the new turbofreighters come into service, there will be a period of high or low fore or aft loading door types. Finally, the third phase will see the displacement of all other types by the end-loaded low-fuselage aircraft. The diagram depicts a terminal for mechanized loading and unloading, equipped with a tow-conveyor (self-powered rail conveyor) which has raising platforms at each end for the loading of high-fuselage aircraft.





In order that cargo pallets of all sizes can be accommodated on the standardized track on board the aircraft, the standardized bases, with flanges at the sides, can be fitted under the pallets. These flanges grip the retaining rails of the roller track, so that the pallets are fixed horizontally and vertically but can easily move along the aircraft over the rollers.

conveyorized system provided the fastest handling of cargo. Three difficulties were, however, inherent in this design:

- outside shipments were difficult to handle;
- all freight was prepared on the conveyor line;
- flexibility was limited in that future expansion became a major high-cost project.

The most efficient and flexible terminal of those analyzed is one incorporating a tow conveyor actuated by an endless chain, to which freight carrying carts can be attached at any point. This terminal, exclusive of a 20 ft by 20 ft office, is approximately 165 ft by 145 ft in size and contains four unit build-up areas.

The gap between terminal and airplane can be bridged by a fixed dock integral with the terminal and also by mobile equipment. The U.S. Air Force utilizes flat-bed trailers and trucks almost exclusively, when loading and unloading its tail-loaded transports. In general, the use of mobile equipment results in decreased ground time, because aircraft manoeuvring time is minimized.

To end-loaded cargo aircraft from any type of vehicle, alignment is required in three directions:

- the end of the vehicle must approach the floor of the aircraft so as to bridge the gap;
- the end of the vehicle must align laterally with the aircraft floor;
- the longitudinal axis of the vehicle must align with the longitudinal axis of the dock.

The use of a vehicle with four-wheel steering meets the general requirements for end-loaded aircraft; furthermore, it simplifies the problem of parking a large vehicle accurately in relation to an expensive easily damaged airplane.

A logical compromise between the fixed dock and vehicular systems of loading, and one that retains most of the advantages of each, is the mobile dock. For example, it combines minimum aircraft positioning requirements with a number of features of fixed docks. Its flexibility approaches that of vehicles, yet its alignment features are superior.

The mobile dock can be used for high-floor aircraft by equipping it with a lift at one or both ends.

Summary of system performance

Summing up, the system described has the following advantages:

- it is compatible with present equipment and facilities;
- it is readily expandable to meet future needs;
- it provides efficient ground operation;
- it enables freight to be rapidly loaded onto the aircraft;
- it requires minimum modification to the aircraft;
- it improves aircraft utilization;
- it reduces costs.

With mechanized loading there can be a saving of almost 25% in man-hours. A far more important and beneficial aspect, however, is the *more than 95% reduction* in airplane ground time for unloading and loading.

Economic evaluations of air freight operations which use time-worn rule-of-thumb criteria for costing are liable to ignore two important factors in connection with indirect costs:

- the decrease in unit indirect cost with increase in cargo traffic;
- the cost savings which can be realized through mechanized loading, despite increase in capital invested in terminal and ground equipment.

The periodical *Manage* for December, 1960 says: "*It was about 200 years ago that the English invented the steam-powered tools that so tremendously multiplied their human energy that no nation on earth could surpass the quality and price of their goods.*

"*But about 100 years ago the English began to let their tools grow old. They forgot that any tool that has become old-fashioned and wastes manpower should be scrapped even though it be in perfect mechanical condition.*"

In fact, the most efficiently conceived and designed cargo airplane will prove financially disappointing if it is shackled to obsolete loading, handling or documentation procedures.

In the choice of a system, therefore, a completely objective approach is necessary to ensure that equal attention is devoted to all aspects of air freight development. Only then will it take its rightful place alongside surface transportation. ↔

Diagram of a modern cargo terminal for handling a daily maximum of over 715,000 lb. In the design of this cargo terminal, it was assumed that during the first 8 peak traffic hours 90% of the cargo would be brought up by trucks, whereas in the remaining 16 hours 10% outward and 90% inward consignments would be handled. The installation comprises a system of tender trucks, which are moved on a chain laid below ground level. In the loops of the cargo track, there is sufficient space for consignments to be temporarily packed. Not counting a 20 ft × 20 ft office, this 165 ft × 145 ft plan includes 4 cargo processing areas. The "bridge" between terminal and aircraft is constituted by a mobile transversal loading ramp. An installation of this type requires by way of personnel 22 all in all, including controllers and office staff.

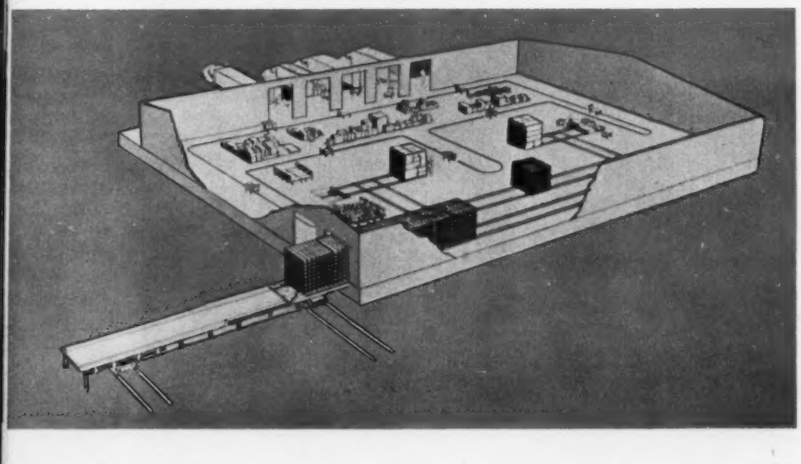
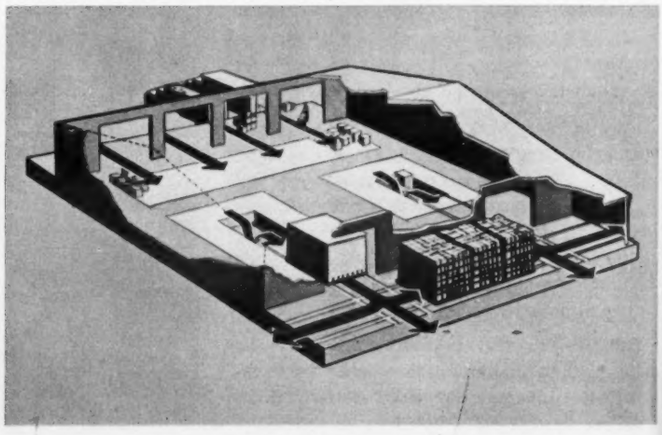


Diagram of a relatively simple terminal with floorspace of 70 ft × 60 ft including an area of 50 ft × 60 ft for storage and processing of cargo. The remaining area is for loading lorries and composing the pallet loads. By means of a terminal of this type up to 900,000 lb of freight can be turned over in 24 hours. At peak hours, i.e., 5 p.m. to 1 a.m., 10 men would be required; at other times this would be reduced to about half. It is intended to equip such buildings with hydraulic platforms; in this way the requisite load height can be achieved by lowering the pallet, thus reducing manpower to a minimum.



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These figures are based on the system used by Air Ministry for determining costs and include fuel, oil, spare parts, replacement of wastage and 3rd and 4th line maintenance at contractors.

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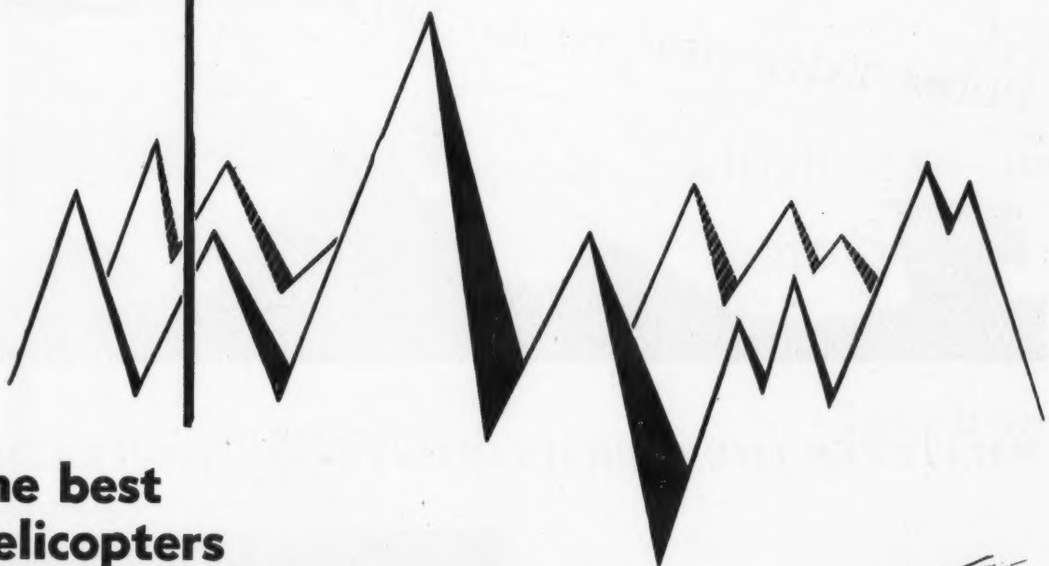
alouette II

WORLD ALTITUDE RECORD FOR HELICOPTERS OF ALL CATEGORIES (11,000 metres on June 13th, 1958)



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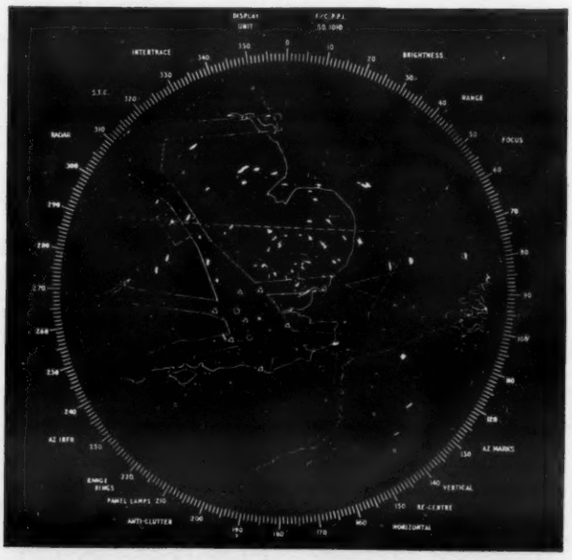

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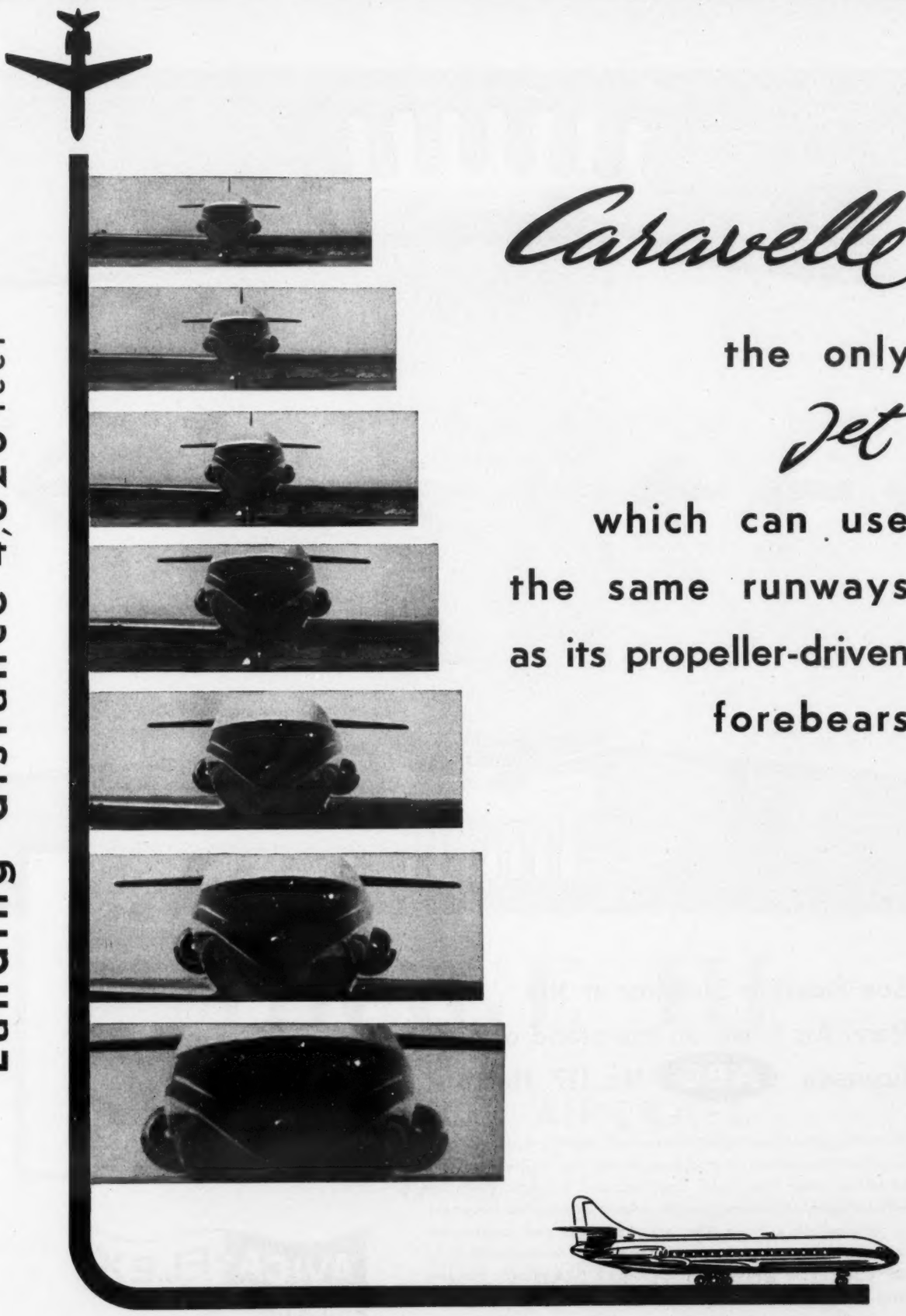

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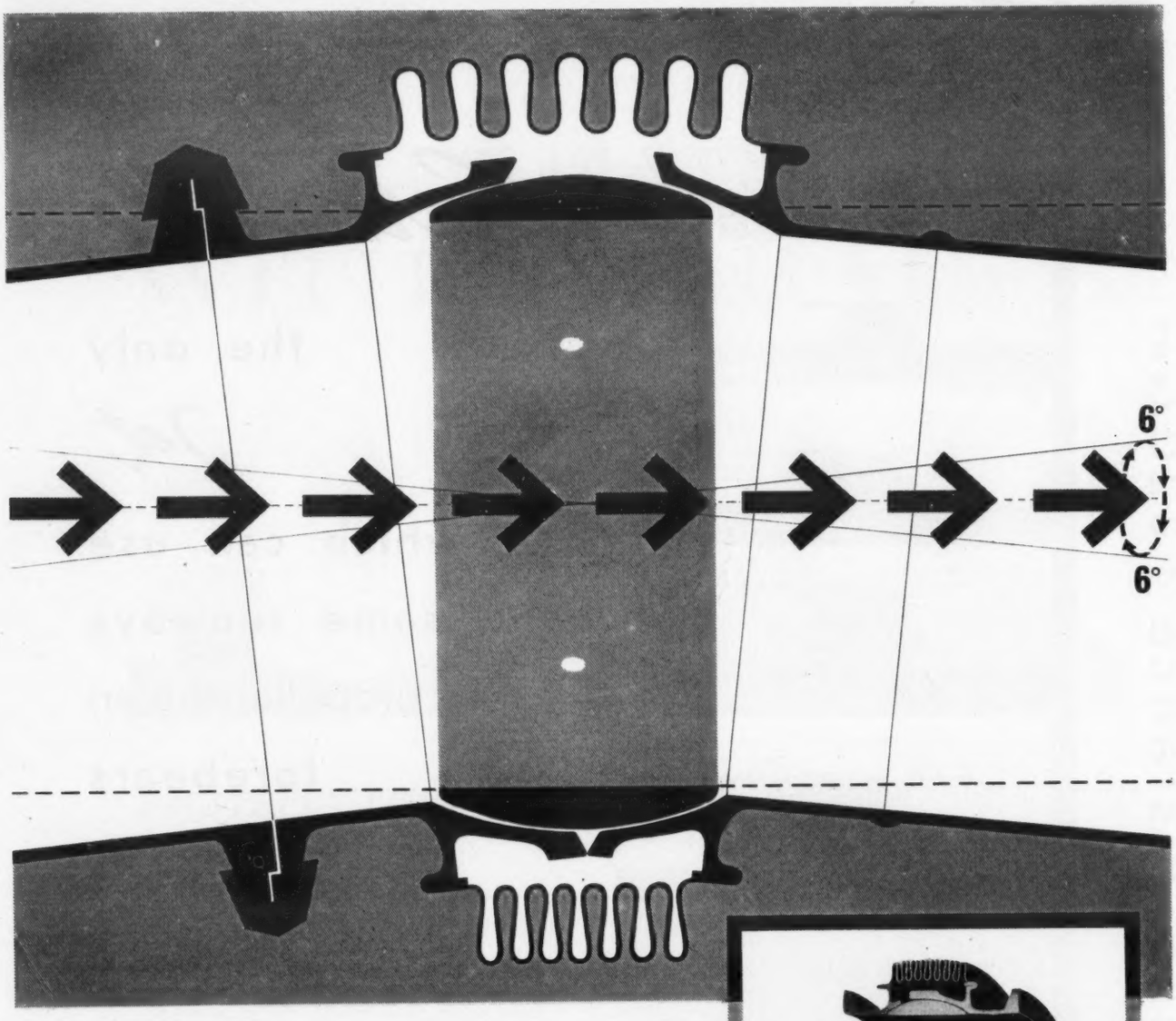

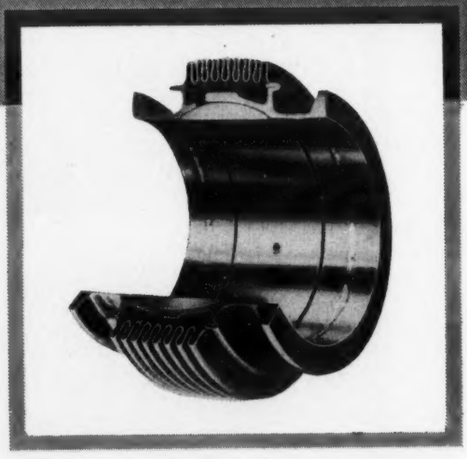

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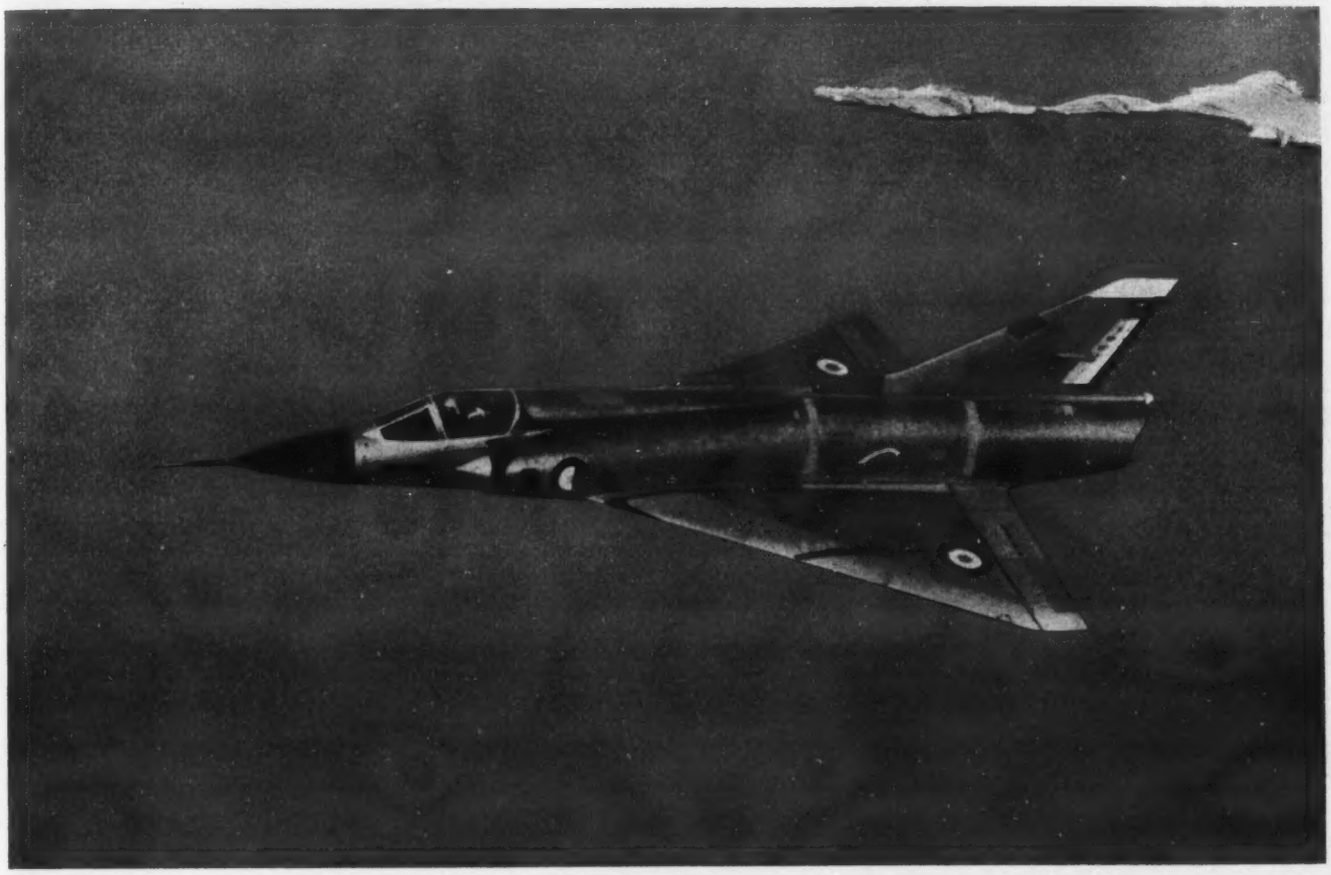

MIRAGE III

INTERCEPTOR AIRCRAFT

Mach 2

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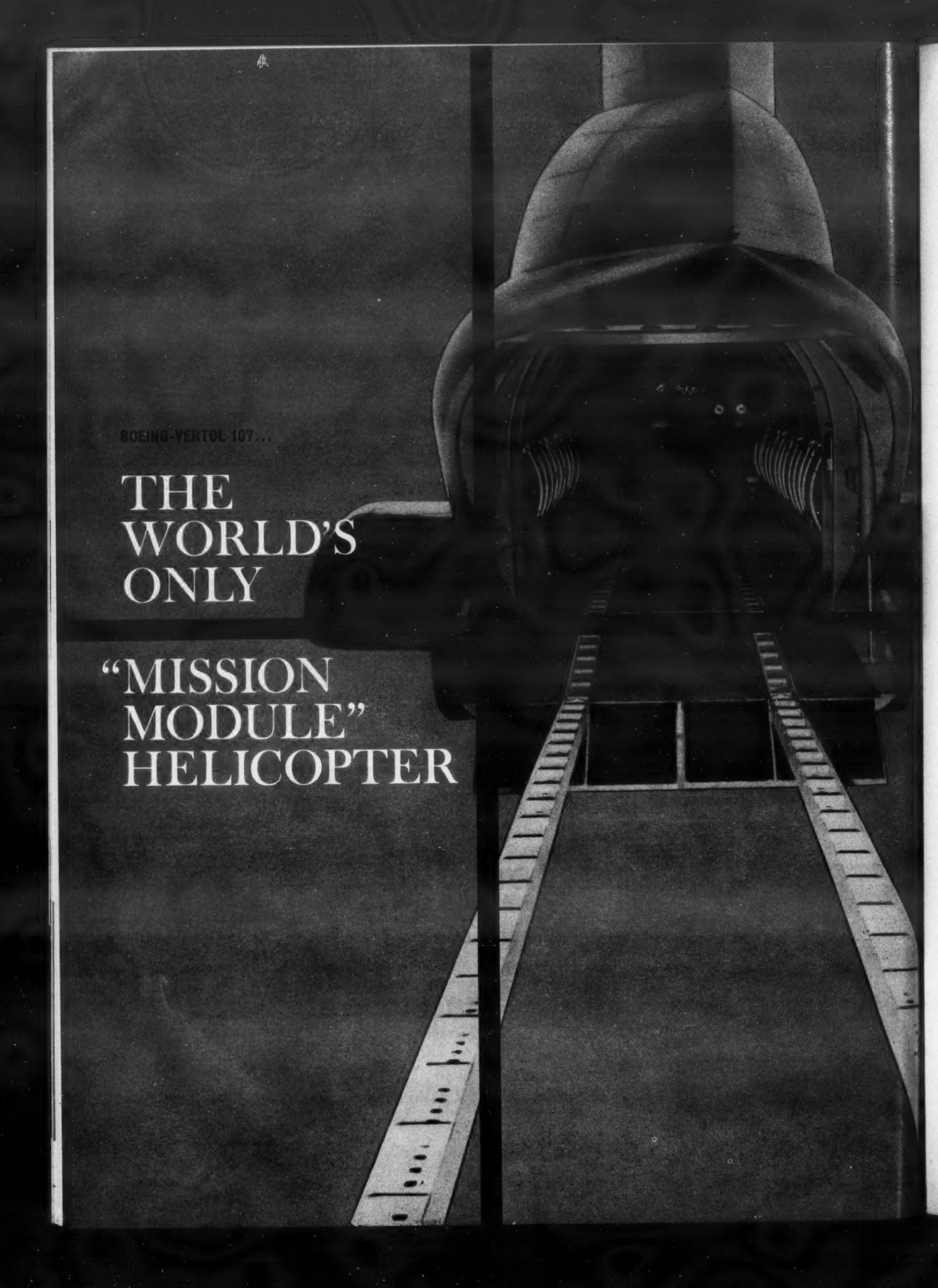
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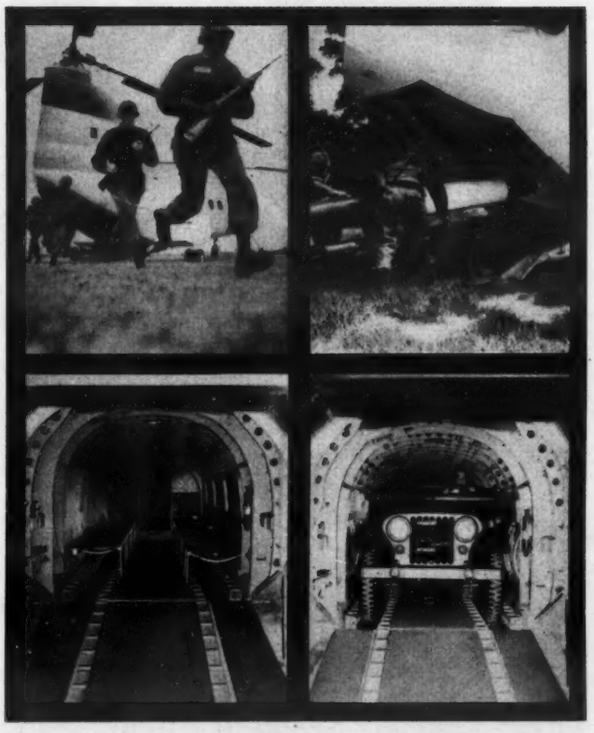
The Boeing Vertol 107's capability to perform many missions such as these makes it the logical choice for today's flexible and alert Armed Forces.



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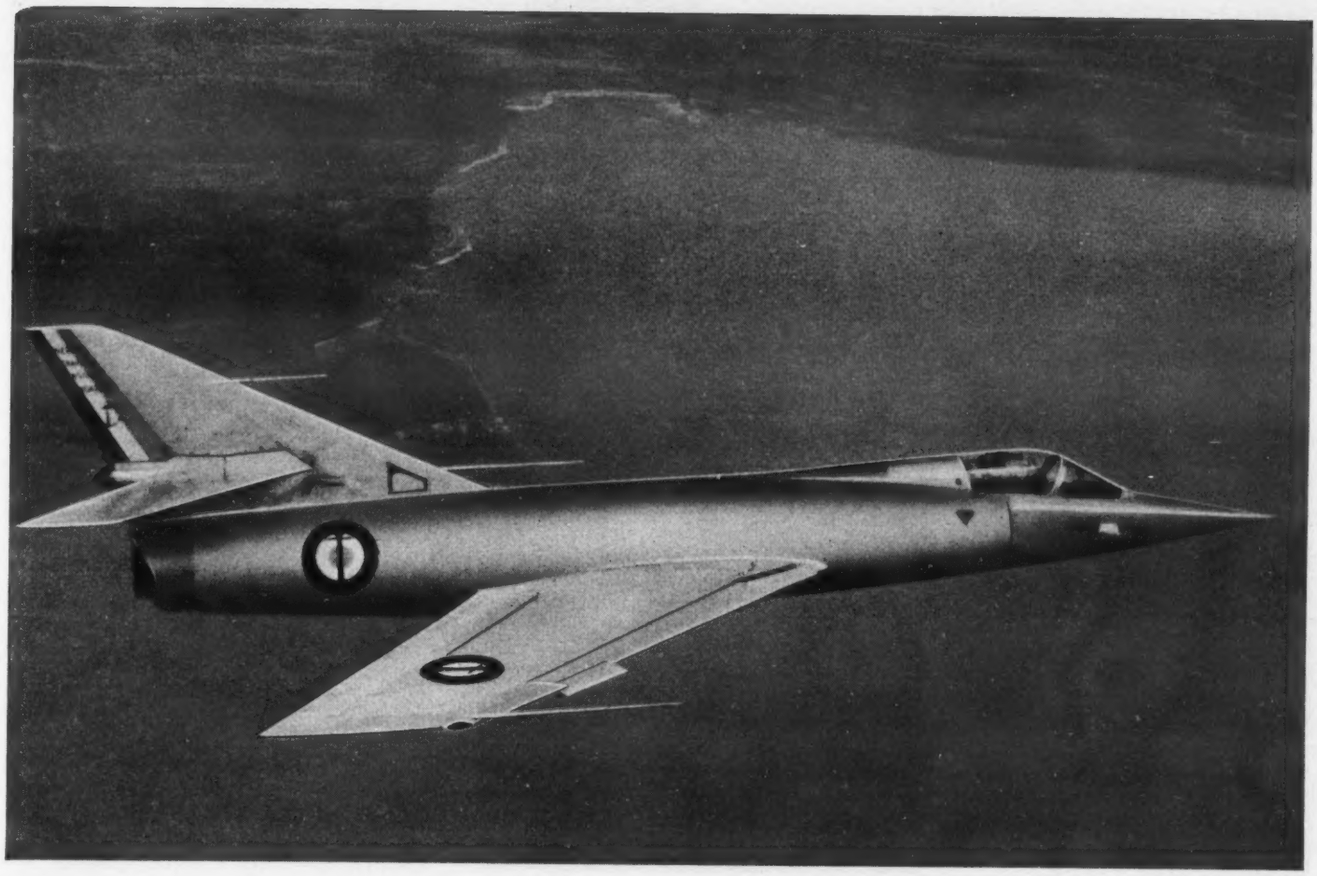

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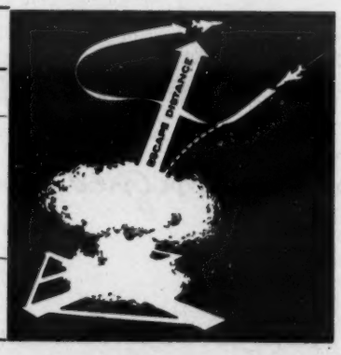
Dive angle	10°—50°
Acceleration in pull-out	3—7 g
Maximum slant range	1,000—15,000m.(3,300—50,000ft.) (depending on speed, dive angle and bomb characteristics)



After thorough testing in France and in competition other with equipment, Aeronavale Française has ordered the SAAB BT9F Toss Bomb Computer for its carrier-based Marcel Dassault Etendard IV fighter-bombers.

The BT9 functions in principle as an analog computer. In a dive, it automatically registers altitude, dive angle, and other variables, from which it derives the correct release point. The pilot only has to direct his plane towards the target and press a pickle switch. Bomb release is automatic. With an auxiliary device, the BT9 is also suitable for firing air-to-ground rockets.

The BT9 which is the latest in a long line of SAAB toss bomb computers is produced by the Company's Jönköping Division.

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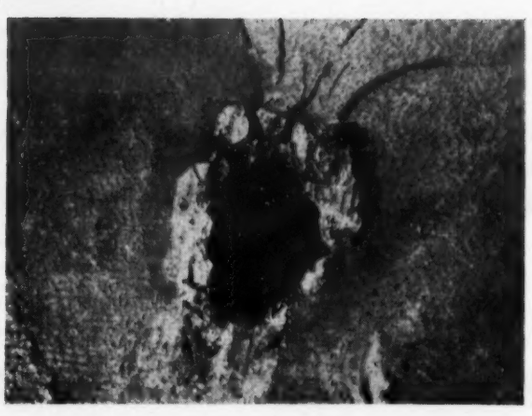

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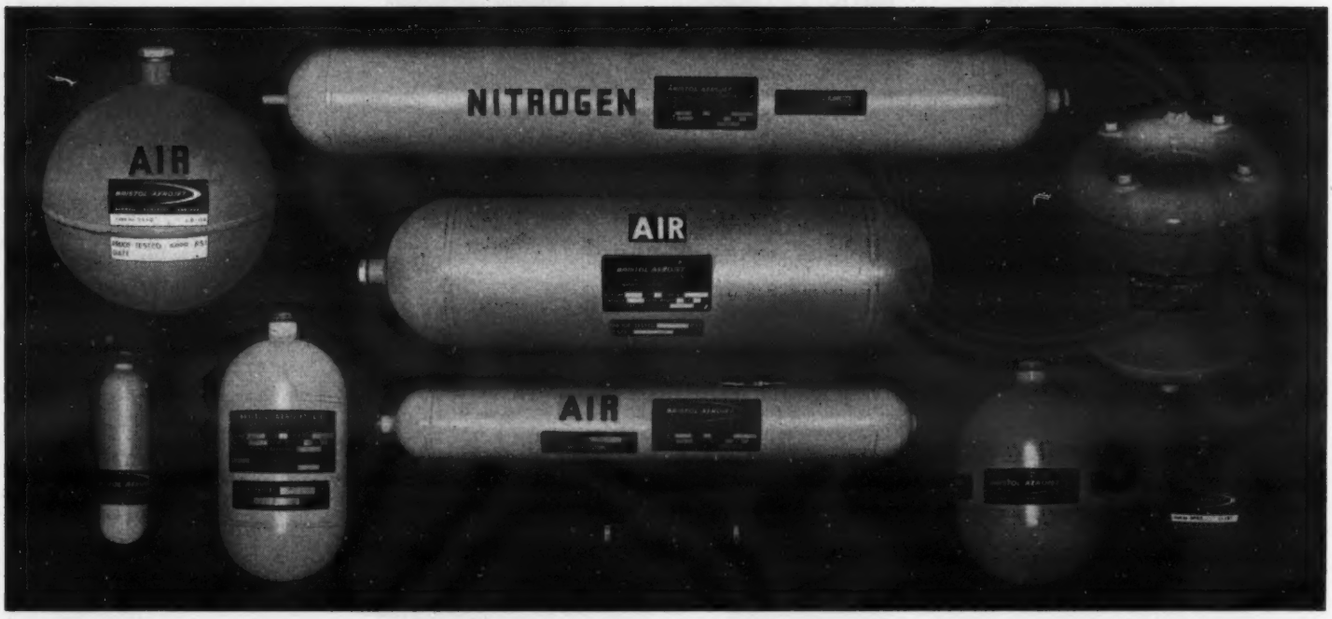

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Four Ryan Q-2C *Firebee* target drones are taken by a Lockheed *Hercules* to an altitude of 16,000 ft, released and left to the mercy of USAF interceptors.

Target and Reconnaissance Drones

Some $90 million are to be spent by the U.S. Army, Navy and Air Force on the development and purchase of target and reconnaissance drones in the current fiscal year (to June 30th 1961). This sum seems paltry when consideration is given to the usefulness of these small unmanned aircraft in modern military operations, and to the continuous improvements in performance and the ever-increasing costs of procurement. Only a few years ago, a drone could be had for a few thousand dollars. Today, up to $150,000 must be paid, and in future certain types for use in the evaluation of new weapon systems will cost as much as half a million dollars.

What is the reason for this increase in cost? In the first place, the tasks of target drones are radically different; whereas formerly they were used only with subsonic aircraft and anti-aircraft artillery, today they must be attuned to the performances of supersonic aircraft and guided missiles. Secondly, more expensive materials, higher performance propellants and more complicated electronic equipment are used. With the introduction of space weapons costs will no doubt rise even further, and it is doubtful whether the greater expense will be offset by the smaller numbers of drones required.

As for the use of obsolete aircraft as target drones, at first sight this seemed an attractive possibility, as gunners and guided missiles would be confronted with a genuine target–although its performance would fall short of those of the most modern weapons. However, the use of new aircraft, such as the *Starfighter* or *Canberra*, converted to drones would be scarcely cheaper than the purchase of drones with correspondingly high performance.

The following pages give a survey of present developments in the field of drones. While the editors have made every effort to include all important information in their table, they fully realize that the list is incomplete and that certain information will be out of date by the time the present issue is published.

The main tasks . . .

The list of missions which can be performed by drones is surprisingly long. So far, they have served mainly as flying targets for training fighter pilots, gunners, artillerymen, radar operators and missile crews and for day and night battle zone reconnaissance. They have, however, other tasks, whose number and significance should increase in coming years. Drones are used, for instance, as communications relay stations and to decoy the enemy's radar defences (an example of the latter application is the McDonnell GAM-72 *Quail*). Fitted with countermeasures of advanced design, they throw the enemy's electronic equipment into confusion and overload his defence organization. Drones are also used to transport supplies—ammunition, food, medicaments—and propaganda material. The Army Chemical Corps Research and Development Command now plans to use them for bacteriological and chemical warfare. The turboprop Radioplane RP-77D is even to serve as a carrier aircraft to transport RP-76 drones to high altitudes. Drones are also used for experimental purposes, in particular to solve problems of aerodynamics and engine performance. Examples of these are the North American X-10, Lockheed X-7 and Nord-Aviation *Vega* (cf. *INTERAVIA*, 4/1961, page 494); the two latter are for experiments with ramjet powerplants. Drones are playing an increasingly important role in the testing and evaluation of new weapon systems, which will shortly count satellites among their numbers. Developments are reaching the stage where manufacturers of new weapons must at the same time develop and supply the appropriate target drones.

. . . demand a variety of configurations

As the illustrations show, target drones are of widely varying configurations to suit their application and speed. Some look like small conventional piston-engine aircraft, while the shape of others recalls the supersonic aircraft of the future.

The sizes of the drones, too, vary widely. The Mach 2 Curtiss-Wright *Skydart* is 6 ft 8 in. long, while the Chance Vought KD2U-1 has a length of 57 ft. Wing spans vary in the same way. The small size of the wings of a number of new target drones is due on the one hand to the high flight speeds, on the other to the requirement for parachute landings.

Weights range from 103 lb for the *Skydart* to 23,000 lb for the KD2U-1. While the former can be handled by two men, the latter requires a whole battery of ground support equipment and trained personnel.

As for methods of construction, more and more plastics are being used. In the case of the Italian Meteor P.1C drone, the entire airframe is of this material. Increasing use is also being made of honeycomb materials. Integral fuel tanks are no rarity, and in the Radioplane RP-76 the combustion chamber

is at the same time the fuselage centre section. Wings and tails of the North American NA-273 are of balsa wood with an aluminium alloy skin. The present article must pass over many details of construction which, though of great interest, cannot be included for lack of space.

Powerplant and performance

All varieties of engines are used in drones. If long endurance is required, but high speeds are not essential, piston engines and propeller turbines are used. For medium endurance and high subsonic speeds, jet engines, in some cases with afterburners, are selected. Now and then ramjet engines are to be found. For the supersonic range, ramjet engines and rocket motors are preferred, the latter giving only a relatively short powered phase.

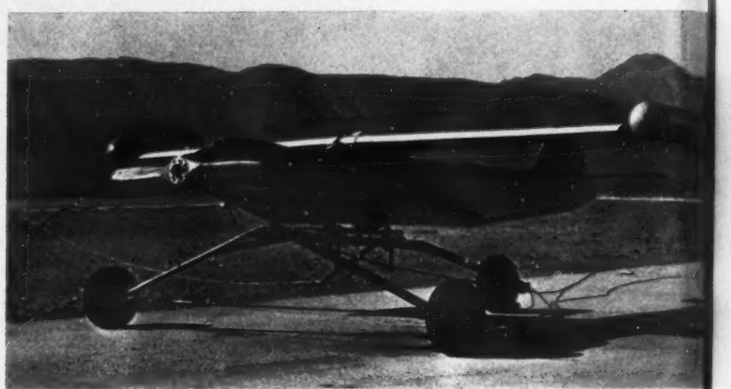
The power of the piston engines normally used in drones lies between 70 and 240 h.p. Of the propeller turbines used, the Boeing 502-10F powering the Radioplane RP-77D target drone is rated at 360 s.h.p. Jet engine thrusts range from 880 lb to 15,000 lb, and those of pulse ramjet engines extend up to 440 lb. Although it is practically impossible to obtain performance data for ramjets and rocket motors, their thrusts range from several hundreds to many thousands of pounds. It is interesting to note that Aeronca is planning a combined ramjet/rocket powerplant for the P-106 and P-107, still under development.

In rocket engines, variable thrust nozzles are being employed to give the drones greater flexibility of operation. The solid-propellant rocket motor of the Temco *Teal* delivers a thrust of 150 lb for take-off and climb, which can be reduced to 50 lb for cruise. With a first-stage thrust of 320,000 lb, the Convair *Atlas* ICBM, which is to serve as a target for the Western Electric/Douglas *Nike-Zeus*, is at present the most powerful "drone." The most powerful launch booster is the Rocketdyne M-34 powering the Chance Vought KD2U-1, with a thrust of 130,000 lb.

The accompanying table gives the main performance data for target and reconnaissance drones. Speeds and ceilings of the most advanced types are fully comparable with those of modern high-performance aircraft and present-day tactical requirements. The fastest drone at present is the Lockheed Q-5 *Kingfisher*, with a speed of 1,950 m.p.h., though the PD-134 being developed by Beech will ultimately fly at five times the speed of sound. Like the new aircraft, the drones must also operate at high altitudes. A number of types can climb to 80,000 ft, and the projected Ryan Q-2D *Firebee* is designed for operation at altitudes of this order. A ceiling of 100,000 ft is quoted for the Aeronca P-106, and the rocket-powered *Pogo-Hi* built by the same company can even reach 116,000 ft.

Also of importance is an endurance adequate to enable the same drone to be attacked a number of times or to collect comprehensive data. Differences in endurance vary widely according to mission. The *Teal* stays in the air for only eight minutes, while the Fairchild AN/USD-5 can remain aloft for two hours. Here it should be stressed that the total flying time of rocket-powered drones is considerably longer than their powered phase.

Powered by a 145 h.p. Continental air-cooled piston engine, the Beechcraft PD-75-4-1, a developed version of the KDB-1, has a top speed of 345 m.p.h. The prototype made its first flight in September 1960.



A more powerful McCulloch piston engine and improved radar augmentation system are features of the E version of the Radioplane OQ-19, the most recent of the series. The new drone is at present undergoing flight tests. Earlier versions of the OQ-19 are operational in the following countries: Belgium, Canada, Nationalist China, Denmark, Great Britain, Iraq, Italy, Japan, South Korea, the Netherlands, Portugal, Spain and the USA.

A Pratt & Whitney jet engine gives the Fairchild AN/USD-5 a maximum speed of Mach 0.9. This reconnaissance drone, which flew for the first time in May, 1960, should be operational early in 1964. Picture shows the prototype being taken back to the U.S. Army's Yuma Test Station, Arizona, after a test flight. The entire short-range reconnaissance system is being developed under the technical direction of the U.S. Army Signal Research and Development Laboratory, Fort Monmouth, New Jersey.

Transport

In designing drones, great stress is laid on small size and weight. In most cases, wings and tail can be either removed or folded. Mounted on a stowage rack, the Beech KDB-1, for instance, occupies only 15 ft × 4 ft 3 in. × 4 ft, and three take up only 15 ft × 4 ft 6 in. × 9 ft. The KDB-1's transport vehicle also serves as a launcher. With the AN/USD-5 reconnaissance drone, Fairchild has succeeded in achieving the same surface mobility as that obtained with present-day tactical guided missiles. The Radioplane Q-4 and its accessories are transported by Lockheed GC-130A *Hercules* aircraft, specially fitted for the purpose.

Launching

A number of methods of launching drones have been developed in the course of the years. These include jettisonable undercarriages, which serve only for take-off, with landings being made either on skids or by parachute. As soon as the drone reaches lift-off speed, it separates from the undercarriage, which is automatically braked. Other drones are launched by compressed air catapults or from ramps. The two rocket boosters of the Nord-Aviation CT.20, for instance, accelerate it to a speed of no less than 375 m.p.h. at the end of its mobile launching ramp. If still more powerful boosters are used, a ramp becomes unnecessary; zero launchings can be made from rudimentary launching devices. Finally, target drones can also be carried by aircraft and released near the point at which they are to operate. In the United States the following aircraft are used for this purpose: Lockheed GC-130 *Hercules* and P2V *Neptune*, Martin GB-26, Douglas JD-1 and a number of fighters.

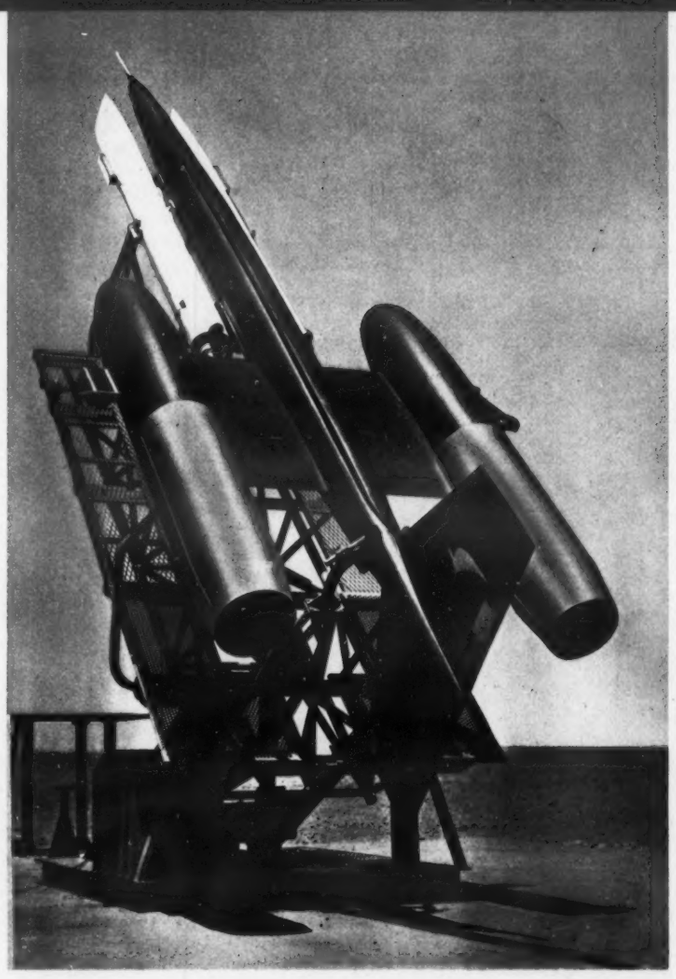
Guidance and Navigation

Once in the air, the drones must be guided, even when they are merely required to fly straight and level. The simplest instrument for this purpose is the autopilot, which is produced in all imaginable forms by a number of firms. In the *Teal*, for instance, an autopilot ensures that the drone flies in a corridor whose horizontal and vertical limits are accurately defined. If the autopilot fails, a destruct device is actuated as soon as the *Teal* deviates from its course by more than 10°.

A second method of guidance is by programme control. All the necessary data are fed into the equipment on the ground and later, during the flight, automatically actuate the devices for regulating the engine and control surfaces.

In addition, there is the radio command procedure, which can override the instructions given by the autopilot or programme control system. The Australian *Jindivik* drone has a relatively simple radio command guidance system, which is actuated by controls on the ground or in aircraft. Two low-frequency tones, which modulate the frequency of a carrier wave, each constitute a guidance signal. By combining any two out of eight tones, the 24 necessary commands can be obtained: 18 for the normal actuation of controls and six for the operation of special equipment such as cameras or infra-red flares. The receiver carried in the drone, which converts combinations of tones into control commands, responds only to signals with the appropriate combination. During approach to land, the *Jindivik* can, if necesssary, receive command signals from two separate systems, which enable it to maintain a more regular flight path.

In the Sperry Phoenix Company's MCG (Microwave Command Guidance) system, commands are transmitted by microwaves. The system consists of a ground station, a relay station in the aircraft accompanying the drone on its mission and a transponder unit in the drone itself. When the ground station is used, tracking, control and the transmission of data are possible over distances of up to 200 miles. If, however, the relay station aboard the escort aircraft is used, range can be increased to 400 miles, and if a number of flying relay stations are employed commands can in theory be trans-



Two ramjet engines give the Nord-Aviation CT-41 target drone a maximum speed of Mach 2.5 and carry it to an altitude of some 65,000 ft in 80 seconds. Nord-Aviation has granted Hawker Siddeley and the Bell Aerospace Corporation licences for the manufacture of the CT. 41.

With a maximum speed of Mach 5, the Beechcraft PD-134 is so far the fastest ramjet-powered target drone under development. It is assisted by two liquid rockets for take-off.

The Lockheed Q-5 *Kingfisher* is also powered by a ramjet. This model, developed from the Lockheed X-7 experimental vehicle, has proved its performance at the White Sands Missile Range in New Mexico as a target for the Bendix *Talos*, Raytheon *Hawk* and Western Electric/Douglas *Nike-Hercules* surface-to-air missiles.

Target and Reconnaissance Drones

Producer	Designation	Purpose [1]	Powerplant	Span / Length	Launch (or Release) Weight (lb)	Maximum Speed (m.p.h.)	Ceiling (ft) / Flight duration (min)	Guidance [2]	Remarks [3]
Australia									
Government Aircraft Factories	Jindivik Mk.2B	T	1 Bristol Siddeley Viper ASV.8 jet engine with 1,750 lb thrust	25′ 7″ / 23′ 4″	2,918	605	55,500 / 40	RC	Improved version of the Mk.2 Jindivik; for training air defence units; radar augmentation; infrared flares; the data apply to the version with lengthened wing and camera containers; otherwise span 19′ 0″.
Government Aircraft Factories	Jindivik Mk.3A	T	1 Bristol Siddeley Viper ASV.11 jet engine with 2,500 lb thrust	25′ 7″ / 23′ 4″	3,152	639	60,000+ / 35	RC	For training air defence units; radar augmentation; infrared flares; operational as from May, 1961.
France									
Nord-Aviation	CT.10	T	1 Arsenal pulse ramjet engine with 440 lb thrust 2 booster rockets	14′ 3″ / 19′ 6″	1,455	280 at 13,120 ft	19,685 / 35	AP; RC	Developed from the German V1; for training air defence units.
Nord-Aviation	CT.20	T	1 Turboméca Marboré II jet engine with 880 lb thrust 2 booster rockets, each with 9,920 lb thrust	11′ 9½″ / 17′ 8″	1,455	560 at 32,800 ft	39,370 / 45 at 33,000 ft	RC	For training air defence units; radar augmentation; flares; smoke generator.
Nord-Aviation	CT.41A	T	2 Nord Sirius ramjet engines, each with 13,230 lb thrust 2 SEPR booster rockets	11′ 11″ / 32′ 2″	2,865	Mach 2.5	65,600 / 14 at Mach 2 and 65,600 ft	AP; RC	For training fighter pilots and missile crews, also evaluation of new air-to-air and surface-to-air missiles; radar augmentation; infrared flares.
Holland									
Aviolanda	AT.21	R	1 SNECMA pulse ramjet engine with 100-150 lb thrust booster rockets	11′ 10″ / 19′	660	215 at 10,000 ft	16,400 / 70	RC	For photographic reconnaissance, also training of air defence units and radar operators; plastic wing; plastic and light metal fuselage.
Italy									
Meteor	P.1	T	1 Meteor G.120CC piston engine (120 h.p.) 1 booster rocket	12′ 1″ / 11′ 1⅛″	485	330 at 26,000 ft	42,650 / 60	AP; RC	For training of air defence units; version P.1AR has radar augmentation; versions P.1AF and P.1ARF have supplementary camera or TV equipment; version P.1ATR has telemetry equipment and radar augmentation; version P.1ATRF has supplementary camera or TV equipment.
Meteor	P.2	R	1 Meteor G.240CC piston engine (240 h.p.) 1 booster rocket	12′ 2″ / 14′ 5¼″	924	323 at sea level	32,800 / 60	AP; RC	For photographic or TV reconnaissance outside visual range. Radius of action about 60 miles.
Japan									
Tachikawa	K-01	T		7′ 10″ / 12′ 4″	485	Mach 1	/ 20		For training air defence units.
Showa	B-3	R	1 Kawasaki ramjet engine with 330 lb thrust	7′ 10″ / 13′ 3″	485	447 at sea level		RC	For TV reconnaissance.
Showa	B-4	R	1 ramjet engine	9′ 7″ / 12′ 1″	661			RC	For TV reconnaissance; B-5 version goes into production early 1962.
USA									
Aerojet-General	Army: AN/USD-2	R	1 Lycoming IMO-360-B1B piston engine (225 h.p.) 2 booster rockets	13′ 4″ / 16′ 1″	1,135	345 at sea level	20,000 / 45	PR; RC	Originally developed by the Rheem Manufacturing Company; for reconnaissance with cameras as well as TV, infrared and radar equipments; new multi-purpose version also suitable for the release of chemical and bacteriological agents.
Aeronca	Pogo-Hi	T	1 Thiokol Cajun solid propellant rocket engine	5′ 1″ / 16′ 4″	320	Mach 2	116,000	PR	For training of missile crews and radar operators; infrared flares.
Beechcraft	PD-75-4-1	T	1 Continental TSIO-200 piston engine (145 h.p.) 2 booster rockets	12′ 11½″ / 14′ 8″	750	345 at 40,000 ft	/ 80		Developed from the Beechcraft 1001; for training air defence units, missile crews and fighter pilots, also for evaluation of new weapon systems.
Beechcraft	PD-121	T	1 ramjet engine 2 booster rockets	4′ 1″ / 20′ 2″	700	Mach 3	80,000	PR	For training missile crews; cruise range 230 miles.
Beechcraft	PD-134	T	1 ramjet engine 2 booster rockets	4′ 8″ / 22′ 6″	1,150	Mach 5	80,000	PR	For training missile crews; cruise range 230 miles.
Beechcraft	PD-143	T	1 Continental J69-T-27 engine with 1,150 lb thrust 2 M58A2 booster rockets	10′ 0″ / 17′ 8″	900	690 at sea level	60,000 / 75 + at 50,000 ft	RC	For training missile personnel and evaluating new weapon systems.
Beechcraft	1001 (Navy: KDB-1)	T	1 McCulloch O-150-4A piston engine (120 h.p.) 2 booster rockets	12′ 6″ / 15′ 0″	635	350+ at 30,000 ft	40,000+ / 60 at 25,000 ft	AP; RC	For training missile crews and fighter pilots; release from North American AJ-2P or launch by compressed air catapult or zero length launcher; also for reconnaissance, for ECM and for supply purposes (max. payload 243 lb).

[1]) T = target drone; R = reconnaissance drone [2]) RC = radio controlled; AP = autopilot; PR = programme [3]) All drones recoverable, unless otherwise stated

Producer	Designation	Purpose	Powerplant	Span / Length	Launch (or Release) Weight (lb)	Maximum Speed (m.p.h.)	Ceiling (ft) / Flight duration (min)	Guidance	Remarks
USA									
Beechcraft	1013	R	1 McCulloch O-150-2 piston engine (110 h.p.)	12′ 8″ / 15′ 0″	600	200	22,800 / 75	RC	Developed from the Beechcraft 1001; for reconnaissance with cameras and TV equipment and for transporting supplies.
Beechcraft	1019 (Navy: XKD2B-1; USAF: Q-12)	T	1 liquid-propellant rocket engine with two combustion chambers for climb and cruise	3′ 3″ / 12′ 6″	600	Mach 2	70,000 / 8 at Mach 1.5	PR	For training fighter pilots and evaluation of new weapon systems, launch from Nike-Ajax ramps or release from aircraft; radar augmentation; infrared flares; expendable; operational as from 1962.
Beechcraft	1025	T	1 McCulloch 6150-J piston engine (120 h.p.) 2 booster rockets	12′ 11½″ / 15′ 1″	635	350+ at 30,000 ft	40,000+ / 60 at 25,000 ft	AP; RC	For training air defence units, missile crews and fighter pilots, also evaluation of new weapon systems.
Bendix	Hilo	T	1 Marquardt ramjet engine booster rockets	3′ 1¾″ / 21′ 6″	776				For training missile crews; radar augmentation; infrared flares; electronic hit indication/ miss distance indication.
Bendix	Penny 1C	T	1 liquid-propellant rocket engine	5′ 4″ / 20′ 0″	950	Mach 1+			For training missile crews and fighter pilots; equipment as for the Hilo (above); release from aircraft; expendable.
Chance Vought	Regulus 1 (Navy: KDU-1)	T	1 Allison J33-A-14 jet engine with 4,600 lb thrust 2 Aerojet-General booster rockets, each with 33,000 lb thrust	21′ 0″ / 33′ 0″	14,522	Mach 1		RC	Developed from the SSM-N-8 Regulus 1 surface-to-surface missile; for training air defence units and missile crews.
Chance Vought	Regulus 2 (Navy: KD2U-1)	T	1 General Electric J79-GE-3A jet engine with 15,000 lb thrust 1 Rocketdyne M-34 booster rocket with 130,000 lb thrust	20′ 0″ / 57′ 0″	23,000	Mach 2	60,000+ / 60	RC; PR	Developed from the SSM-N-9 Regulus 2 surface-to-surface missile; for evaluation of new air-to-air and surface-to-air missiles.
Curtiss-Wright	Skydart TDU-12	T	1 Grand Central solid propellant rocket	1′ 9″ / 6′ 8″	103	Mach 2	65,000 / 1.5+	AP	For training fighter pilots and evaluation of air-to-air missiles with infrared homing heads; release from aircraft; expendable.
Fairchild	Army: AN/USD-5	R	1 Pratt & Whitney J60-P-2 jet engine with 2,900 lb thrust 1 booster rocket with 48,000 lb thrust	24′ 0″ / 36′ 0″	8,500	Mach 0.9		PR; RC	For reconnaissance with aid of electronic equipment; airframe principally of fibreglass-reinforced plastic.
Lockheed	Kingfisher (USAF: Q-5)	T	1 Marquardt RJ43-MA-5 ramjet engine 2 booster rockets	10′ 0″ / 58′ 0″	7,600 without payload	1,950	80,000 / 11	AP	For training missile crews; radar augmentation; electronic miss distance indication; release from aircraft.
North American	NA-273	T	1 Marquardt ramjet engine 1 Rocketdyne booster rocket with 6,000 lb thrust	6′ 3″ / 18′ 8″	958	Mach 2	50,000	RC	For training missile crews; for photo see *Interavia* 12/1960, page 1531; minimum ramjet engine running time at subsonic speeds and low altitudes (300 ft) 6-10 min, at supersonic speeds 3 min, at supersonic speeds and high altitudes 6 min.
Radioplane	OQ-19 (USAF and Army: OQ-19B and OQ-19D, Navy: KD2R-5)	T	1 McCulloch O-100-1 piston engine (72 h.p.)	13′ 2¼″ / 12′ 3″	327	222 at sea level	23,000 / 60	RC	For training air defence units and missile crews; radar augmentation.
Radioplane	OQ-19E	T	1 McCulloch O-150-2 piston engine (110 h.p.)	11′ 6″ / 12′ 6″	405	256 at sea level	25,000 / 60	AP; RC	For training missile crews and evaluating new surface-to-air missiles; radar augmentation equipment in wing-tip pods; undergoing flight tests.
Radioplane	USAF: Q-4B	T	1 General Electric J85-GE-5 jet engine with 3,850 lb thrust	13′ 0″ / 36′ 0″	3,300	Mach 2	70,000+ / 60	RC	For training fighter pilots and missile crews and evaluating new air-to-air and surface-to-air missiles; undergoing flight tests.
Radioplane	RP-70 (Navy: XKD4R-1)	T	1 Aerojet-General solid-propellant rocket engine with 35 lb thrust	5′ 0″ / 9′ 6″	305	Mach 0.95	50,000 / 10	AP	For training missile crews; expendable; airframe mainly of plastic.
Radioplane	RP-71 (Army: SD-1)	R	1 McCulloch O-100-1 piston engine (72 h.p.)	11′ 6″ / 13′ 5″	430	184	15,000 / 40	RC	For photographic and cinematographic reconnaissance.
Radioplane	RP-76 (Navy: KD4R-1)	T	1 Aerojet-General 530NS-35 solid-propellant rocket engine	5′ 0″ / 9′ 0″	300	Mach 0.9	60,000+ / 23	PR; RC	For training missile crews and fighter pilots; release from aircraft; radar augmentation; miss distance indication.
Radioplane	RP-77D	T	1 Boeing 502-10S turbo-prop (360 s.h.p.) 2 Loki or Falcon booster rockets	19′ 0″ / 14′ 10⅞″	1,050	417 at 30,000 ft	47,000 / 75	AP; RC	For training air defence units and missile crews and testing auxiliary equipment; can also be fitted out for reconnaissance; radar augmentation; miss distance indication; undergoing flight tests.
Republic	Swallow (Army: AN/USD-4)	R	1 Pratt & Whitney J60-P-2 jet engine with 2,900 lb thrust 2 Arrow 2 booster rockets	11′ 0″ / 32′ 0″	3,500	500	60,000	PR; RC	For photographic, cinematographic, radar and infrared reconnaissance.
Ryan	Firebee (USAF: Q-2C)	T	1 Continental J69-T-29 jet engine with 1,700 lb thrust	12′ 10⅞″ / 22′ 11″	2,500	Mach 0.90 at 50,000 ft	50,000 / 75+	AP; RC	Further development of the Q-2A; for fighter pilot and missile crew training and evaluation of new air-to-air and surface-to-air missiles; radar augmentation; release from aircraft.
Ryan	Firebee (Navy: KDA-4)	T	1 Fairchild J44-R-20 jet engine with 1,000 lb thrust	11′ 2″ / 17′ 6″	1,900	575 at 40,000 ft	40,000 / 50	AP; RC	Same purpose as Q-2C; radar augmentation and infrared flares; release from aircraft.
Temco	Teal (Navy: XKDT-1)	T	1 Astrodyne solid-propellant rocket engine with 150 lb launch thrust and 50 lb cruise thrust	4′ 11″ / 11′ 6⅞″	350	Mach 0.85 at 50,000 ft	55,000 / 8 at 45,000 ft	AP; PR	For training fighter pilots; radar augmentation; infrared flares; expendable.

Target and Reconnaissance Drones

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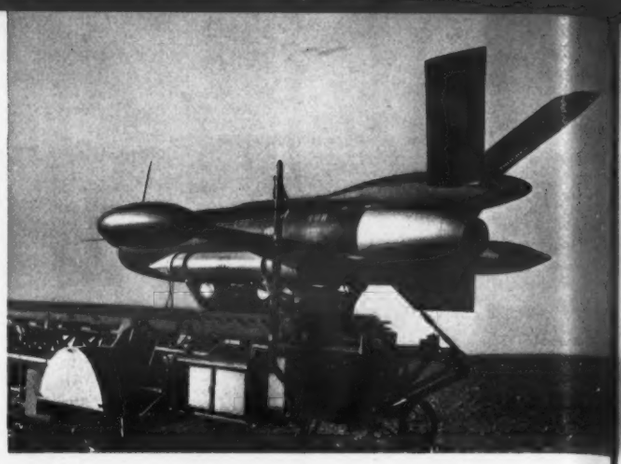
Government Aircraft Factories	Jindivik Mk.3A	T	1 Bristol Siddeley Viper ASV.11 jet engine with 2,500 lb thrust	25′ 7″ / 23′ 4″	3,152	639	60,000+ / 35	RC	For training air defence units; radar augmentation; infrared flares; operational as from May, 1961.
France									
Nord-Aviation	CT.10	T	1 Arsenal pulse ramjet engine with 440 lb thrust 2 booster rockets	14′ 3″ / 19′ 6″	1,455	280 at 13,120 ft	19,685 / 35	AP; RC	Developed from the German V1; for training air defence units.
Nord-Aviation	CT.20	T	1 Turboméca Marboré II jet engine with 880 lb thrust 2 booster rockets, each with 9,920 lb thrust	11′ 9½″ / 17′ 8″	1,455	560 at 32,800 ft	39,370 / 45 at 33,000 ft	RC	For training air defence units; radar augmentation; flares; smoke generator.
Nord-Aviation	CT.41A	T	2 Nord Sirius ramjet engines, each with 13,230 lb thrust 2 SEPR booster rockets	11′ 11″ / 32′ 2″	2,865	Mach 2.5	65,600 / 14 at Mach 2 and 65,600 ft	AP; RC	For training fighter pilots and missile crews, also evaluation of new air-to-air and surface-to-air missiles; radar augmentation; infrared flares.
Holland									
Aviolanda	AT.21	R	1 SNECMA pulse ramjet engine with 100-150 lb thrust booster rockets	11′ 10″ / 18′	660	215 at 10,000 ft	16,400 / 70	RC	For photographic reconnaissance, also training of air defence units and radar operators; plastic wing; plastic and light metal fuselage.
Italy									
Meteor	P.1	T	1 Meteor G.120CC piston engine (120 h.p.) 1 booster rocket	12′ 1″ / 11′ 1¼″	495	330 at 26,000 ft	42,650 / 60	AP; RC	For training of air defence units; version P.1AR has radar augmentation; versions P.1AF and P.1ARF have supplementary camera or TV equipment; version P.1ATR has telemetry equipment and radar augmentation; version P.1ATRF has supplementary camera or TV equipment.
Meteor	P.2	R	1 Meteor G.240CC piston engine (240 h.p.) 1 booster rocket	12′ 2″ / 14′ 5¼″	924	323 at sea level	32,800 / 60	AP; RC	For photographic or TV reconnaissance outside visual range. Radius of action about 60 miles.
Japan									
Tachikawa	K-01	T		7′ 10″ / 12′ 4″	485	Mach 1	— / 20		For training air defence units.
Showa	B-3	R	1 Kawasaki ramjet engine with 330 lb thrust	7′ 10″ / 13′ 3″	485	447 at sea level		RC	For TV reconnaissance.
Showa	B-4	R	1 ramjet engine	9′ 7″ / 12′ 1″	661			RC	For TV reconnaissance; B-5 version goes into production early 1962.
USA									
Aerojet-General	Army: AN/USD-2	R	1 Lycoming IMO-360-B1B piston engine (225 h.p.) 2 booster rockets	13′ 4″ / 16′ 1″	1,135	345 at sea level	20,000 / 45	PR; RC	Originally developed by the Rheem Manufacturing Company; for reconnaissance with cameras as well as TV, infrared and radar equipments; new multi-purpose version also suitable for the release of chemical and bacteriological agents.
Aeronca	Pogo-Hi	T	1 Thiokol Cajun solid propellant rocket engine	2′ 1″ / 16′ 4″	220	Mach 2	116,000	PR	For training of missile crews and radar operators; infrared flares.
Beechcraft	PD-75-4-1	T	1 Continental TSIO-200 piston engine (145 h.p.) 2 booster rockets	12′ 11½″ / 14′ 8″	750	345 at 40,000 ft	— / 80		Developed from the Beechcraft 1001; for training air defence units, missile crews and fighter pilots, also for evaluation of new weapon systems.
Beechcraft	PD-121	T	1 ramjet engine 2 booster rockets	4′ 1″ / 20′ 2″	700	Mach 3	80,000	PR	For training missile crews; cruise range 230 miles.
Beechcraft	PD-134	T	1 ramjet engine 2 booster rockets	4′ 6″ / 22′ 6″	1,150	Mach 5	80,000	PR	For training missile crews; cruise range 230 miles.
Beechcraft	PD-143	T	1 Continental J69-T-27 engine with 1,150 lb thrust 2 M58A2 booster rockets	10′ 0″ / 17′ 8″	900	690 at sea level	60,000 / 75 + at 50,000 ft	RC	For training missile personnel and evaluating new weapon systems.
Beechcraft	1001 (Navy: KDB-1)	T	1 McCulloch O-150-4A piston engine (120 h.p.) 2 booster rockets	12′ 6″ / 15′ 0″	635	350+ at 30,000 ft	40,000+ / 60 at 25,000 ft	AP; RC	For training missile crews and fighter pilots; release from North American AJ-2P or launch by compressed air catapult or zero length launcher; also for reconnaissance, for ECM and for supply purposes (max. payload 243 lb).

[1] T = target drone; R = reconnaissance drone [2] RC = radio controlled; AP = autopilot; PR = programme [3] All drones recoverable, unless otherwise stated

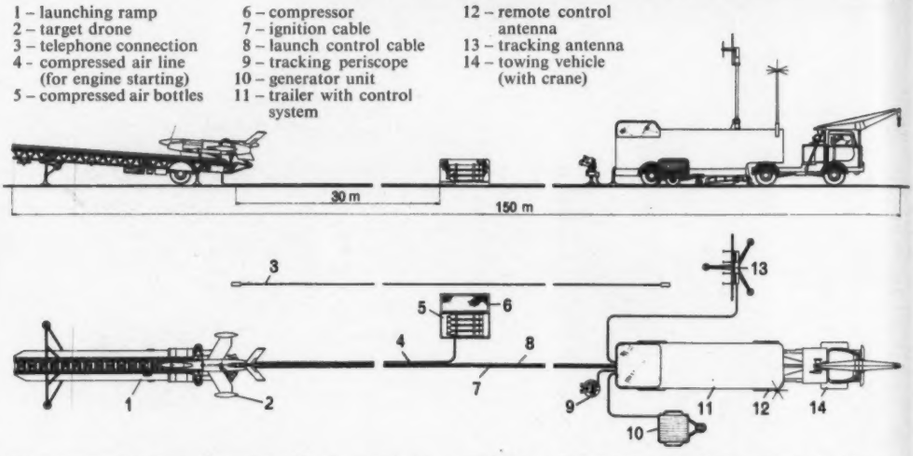
Producer	Designation	Purpose	Powerplant	Span / Length	Launch (or Release) Weight (lb)	Maximum Speed (m.p.h.)	Ceiling (ft) / Flight duration (min)	Guidance	Remarks
USA									
Beechcraft	1013	R	1 McCulloch O-150-2 piston engine (110 h.p.)	12′ 6″ / 15′ 0″	800	260	22,800 / 75	RC	Developed from the Beechcraft 1001; for reconnaissance with cameras and TV equipment and for transporting supplies.
Beechcraft	1019 (Navy: XKD2B-1; USAF: Q-12)	T	1 liquid-propellant rocket engine with two combustion chambers for climb and cruise	3′ 3″ / 12′ 6″	600	Mach 2	70,000 / 8 at Mach 1.5	PR	For training fighter pilots and evaluation of new weapon systems, launch from Nike-Ajax ramps or release from aircraft; radar augmentation; infrared flares; expendable; operational as from 1962.
Beechcraft	1025	T	1 McCulloch 6150-J piston engine (120 h.p.) 2 booster rockets	12′ 11½″ / 15′ 1″	635	350+ at 30,000 ft	40,000+ / 60 at 25,000 ft	AP; RC	For training air defence units, missile crews and fighter pilots, also evaluation of new weapon systems.
Bendix	Hilo	T	1 Marquardt ramjet engine booster rockets	3′ 1½″ / 21′ 6″	778				For training missile crews; radar augmentation; infrared flares; electronic hit indication/miss distance indication.
Bendix	Penny 1C	T	1 liquid-propellant rocket engine	5′ 4″ / 20′ 0″	950	Mach 1+			For training missile crews and fighter pilots; equipment as for the Hilo (above); release from aircraft; expendable.
Chance Vought	Regulus 1 (Navy: KDU-1)	T	1 Allison J33-A-14 jet engine with 4,600 lb thrust 2 Aerojet-General booster rockets, each with 33,000 lb thrust	21′ 0″ / 33′ 0″	14,522	Mach 1		RC	Developed from the SSM-N-8 Regulus 1 surface-to-surface missile; for training air defence units and missile crews.
Chance Vought	Regulus 2 (Navy: KD2U-1)	T	1 General Electric J79-GE-3A jet engine with 15,000 lb thrust 1 Rocketdyne M-34 booster rocket with 130,000 lb thrust	20′ 0″ / 57′ 0″	23,000	Mach 2	60,000+ / 60	RC; PR	Developed from the SSM-N-9 Regulus 2 surface-to-surface missile; for evaluation of new air-to-air and surface-to-air missiles.
Curtiss-Wright	Skydart TDU-12	T	1 Grand Central solid propellant rocket	1′ 9″ / 6′ 8″	103	Mach 2	65,000 / 1.5+	AP	For training fighter pilots and evaluation of air-to-air missiles with infrared homing heads; release from aircraft; expendable.
Fairchild	Army: AN/USD-5	R	1 Pratt & Whitney J60-P-2 jet engine with 2,900 lb thrust 1 booster rocket with 48,000 lb thrust	24′ 0″ / 36′ 0″	8,500	Mach 0.9		PR; RC	For reconnaissance with aid of electronic equipment; airframe principally of fibreglass-reinforced plastic.
Lockheed	Kingfisher (USAF: Q-5)	T	1 Marquardt RJ43-MA-5 ramjet engine 2 booster rockets	10′ 0″ / 38′ 0″	7,600 without payload	1,950	80,000 / 11	AP	For training missile crews; radar augmentation; electronic miss distance indication; release from aircraft.
North American	NA-273	T	1 Marquardt ramjet engine 1 Rocketdyne booster rocket with 6,000 lb thrust	6′ 3″ / 18′ 8″	958	Mach 2	50,000	RC	For training missile crews; for photo see *Interavia* 12/1960, page 1531; minimum ramjet engine running time at subsonic speeds and low altitudes (300 ft) 6-10 min, at supersonic speeds 3 min, at supersonic speeds and high altitudes 6 min.
Radioplane	OQ-19 (USAF and Army: OQ-19B and OQ-19D, Navy: KD2R-5)	T	1 McCulloch O-100-1 piston engine (72 h.p.)	13′ 2½″ / 12′ 3″	327	222 at sea level	23,000 / 60	RC	For training air defence units and missile crews; radar augmentation.
Radioplane	OQ-19E	T	1 McCulloch O-150-2 piston engine (110 h.p.)	11′ 6″ / 12′ 6″	405	256 at sea level	25,000 / 60	AP; RC	For training missile crews and evaluating new surface-to-air missiles; radar augmentation equipment in wing-tip pods; undergoing flight tests.
Radioplane	USAF: Q-4B	T	1 General Electric J85-GE-5 jet engine with 3,850 lb thrust	13′ 0″ / 36′ 0″	3,300	Mach 2	70,000+ / 60	RC	For training fighter pilots and missile crews and evaluating new air-to-air and surface-to-air missiles; undergoing flight tests.
Radioplane	RP-70 (Navy: XKD4R-1)	T	1 Aerojet-General solid-propellant rocket engine with 35 lb thrust	5′ 0″ / 9′ 6″	305	Mach 0.95	50,000 / 10	AP	For training missile crews; expendable; airframe mainly of plastic.
Radioplane	RP-71 (Army: SD-1)	R	1 McCulloch O-100-1 piston engine (72 h.p.)	11′ 6″ / 13′ 5″	430	184	15,000 / 40	RC	For photographic and cinematographic reconnaissance.
Radioplane	RP-76 (Navy: KD4R-1)	T	1 Aerojet-General 530NS-35 solid-propellant rocket engine	5′ 0″ / 9′ 8″	300	Mach 0.9	60,000+ / 23	PR; RC	For training missile crews and fighter pilots; release from aircraft; radar augmentation; miss distance indication.
Radioplane	RP-77D	T	1 Boeing 502-10S turbo-prop (360 s.h.p.) 2 Loki or Falcon booster rockets	19′ 0″ / 14′ 10½″	1,050	417 at 30,000 ft	47,000 / 75	AP; RC	For training air defence units and missile crews and testing auxiliary equipment; can also be fitted out for reconnaissance; radar augmentation; miss distance indication; undergoing flight tests.
Republic	Swallow (Army: AN/USD-4)	R	1 Pratt & Whitney J60-P-2 jet engine with 2,900 lb thrust 2 Arrow 2 booster rockets	11′ 0″ / 32′ 0″	3,500	800	60,000	PR; RC	For photographic, cinematographic, radar and infrared reconnaissance.
Ryan	Firebee (USAF: Q-2C)	T	1 Continental J69-T-29 jet engine with 1,700 lb thrust	12′ 10½″ / 22′ 11″	2,500	Mach 0.96 at 50,000 ft	50,000 / 75+	AP; RC	Further development of the Q-2A; for fighter pilot and missile crew training and evaluation of new air-to-air and surface-to-air missiles; radar augmentation; release from aircraft.
Ryan	Firebee (Navy: KDA-4)	T	1 Fairchild J44-R-20 jet engine with 1,000 lb thrust	11′ 2″ / 17′ 6″	1,900	575 at 40,000 ft	40,000 / 53	AP; RC	Same purpose as Q-2C; radar augmentation and infrared flares; release from aircraft.
Temco	Teal (Navy: XKDT-1)	T	1 Astrodyne solid-propellant rocket engine with 150 lb launch thrust and 50 lb cruise thrust	4′ 11″ / 11′ 6½″	350	Mach 0.95 at 50,000 ft	55,000 / 8 at 45,000 ft	AP; PR	For training fighter pilots; radar augmentation; infrared flares; expendable.

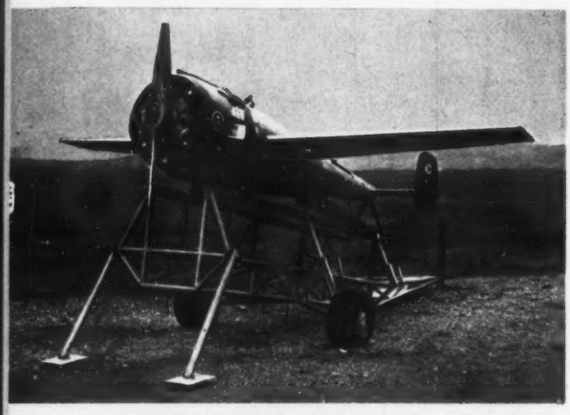
mitted over unlimited distances. The drone can also be guided directly from an aircraft.

Tracking—a prerequisite of any radio guidance system—can be carried out optically or electronically, the most commonly used tracking equipment being the radar. Page 359 of the March issue of *Interavia* Review contained a detailed report on the RPTA tracking system developed by the Northrop Radioplane Division. The Minneapolis-Honeywell Regulator Company has developed the *Visicorder* specially for tracking reconnaissance drones; this is used in conjunction with a mobile tactical command station built by the Tele-Dynamics Division of American Bosch Arma and records time signals and 22 different kinds of data from the drone on a twelve-inch band.

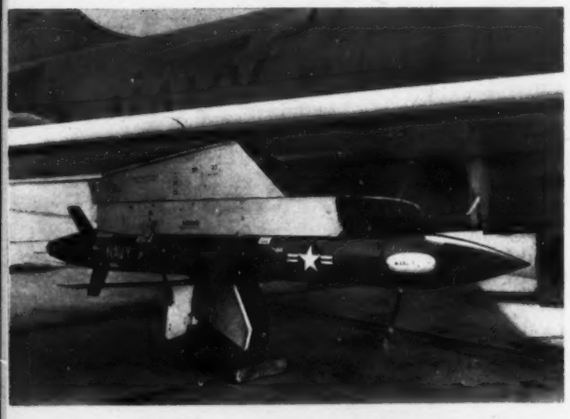


The Nord-Aviation CT.20 target drone is launched from a 33 ft ramp (right). After launching by two solid-propellant boosters, the drone is powered for the rest of its flight by a Turboméca jet engine. By mid-1960 Nord-Aviation had delivered some 350 CT.20s to the French, British, Italian and Swedish Forces; a further hundred are under construction. Bell Aerospace Corporation is sales agent in the United States. Below, a diagram of the CT.20 launcher.


1 – launching ramp
2 – target drone
3 – telephone connection
4 – compressed air line (for engine starting)
5 – compressed air bottles
6 – compressor
7 – ignition cable
8 – launch control cable
9 – tracking periscope
10 – generator unit
11 – trailer with control system
12 – remote control antenna
13 – tracking antenna
14 – towing vehicle (with crane)
30 m
150 m



A small trailer of welded steel tubes suffices for the transport of the Meteor target and reconnaissance drone (P. 0 version is illustrated). The wings can be mounted rapidly and easily, and the trailer, anchored to the ground, can also be used as a launcher.



The Temco *Teal*, powered by an Astrodyne rocket motor, is released from aircraft. Among the carrier aircraft used by the U.S. Navy is the McDonnell F3H-2 *Demon* illustrated here.

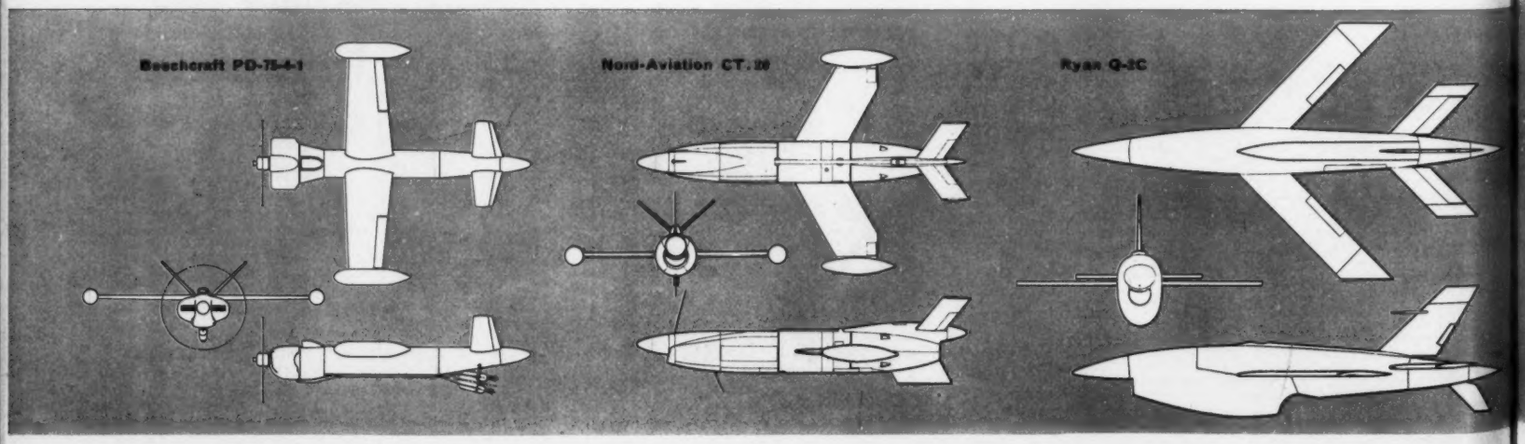
Use has recently been made of inertial guidance. Minneapolis-Honeywell is at present developing a miniaturized system for installation in the Fairchild AN/USD-5 reconnaissance drone. The system will reportedly guide the AN/USD-5 to its operating region some hundreds of miles away, transmit the coordinates of targets which have been detected and ensure that the drone returns to its base. There is no radio connection which could be jammed by the enemy.

The doppler autonomous navigation system is now being introduced for use in target drones. Motorola Aviation Electronics Inc., of Santa Monica, California, is at present building a system of this kind, combined with a low-frequency hyperbolic navigation system; a computer supplies commands from the data furnished by both systems.

Drones for target practice . . .

The foregoing remarks apply on the whole to all kinds of drones; the present section deals exclusively with target drones. Their mission profile depends on their flight endurance and the performance of the weapon systems to be used against them. Some examples of the use of the Radioplane RP-76 as a target for Raytheon *Hawk* and Western Electric/Douglas *Nike-Ajax* and *Nike-Hercules* were given in *Interavia* No. 3/1961, page 357.

During aerial combat training, target drones must be able to perform typical evasive movements; in simulated low-level attacks, they must follow prescribed flight paths at high speeds and low levels; and when representing ICBMs they must approach the anti-missile missile emplacements on ballistic courses.



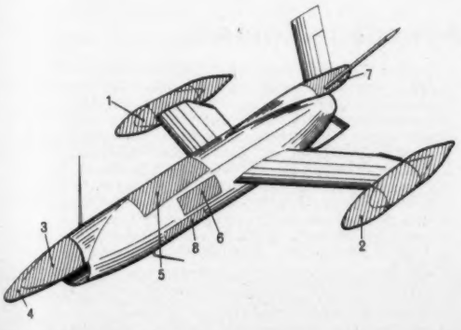
As drones are in most cases smaller than the targets which they represent, various means are employed to simulate the full size or other characteristics of the presumed targets. Infra-red flares simulate the heat generated by large jet, ramjet and rocket engines, enabling missiles with infra-red homing heads to home on their targets. The *Jindivik* tows its infra-red flares on a long line behind it, so that it is not destroyed by exploding guided missiles. Smoke cartridges aid attacking fighters in recognizing their targets.

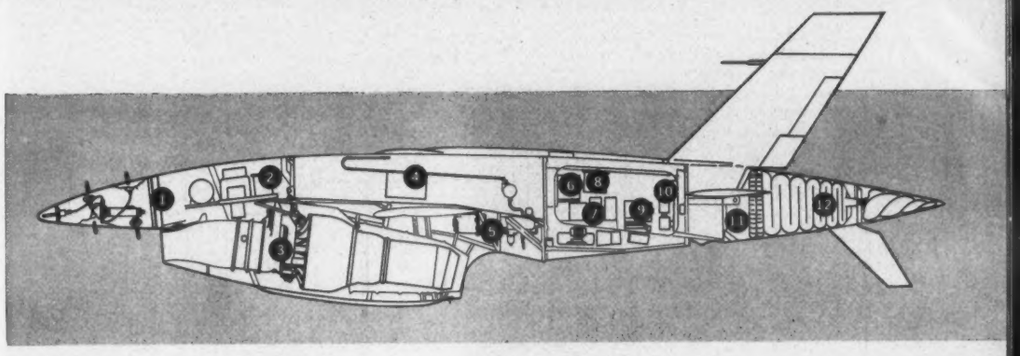
If radar devices are used for homing, augmenters carried by the drones increase the size of the echoes to simulate those of large aircraft. These can be either monostatic or bistatic, and use either Luneberg lenses or travelling-wave tubes. The SEE (Sperry Echo Enhancer) system developed by Sperry uses a travelling-wave tube of this kind, which reradiates over a wide microwave spectrum the radar signals which it receives. The degree of augmentation can be regulated from the ground. The SEE system can operate at Mach 2 and altitudes of over 50,000 ft.

Equipment compartments in the Nord-Aviation CT.20.

Compartment	Dimensions (in.)	Volume (cu. ft.)	Equipment weight (lb)
1	51 × 12 diam.	1.87	11
2	72½ × 12 diam.	2.61	81
3	24 × 12½ max. diam.	0.88	55
4	26½ × 12½ max. diam.	1.27	55
5	35½ × 9 × 28¼	2.83	110
6	4 × 8¼ × 29¾	0.35	22
7	27¾ × 4 max. diam.	0.18	11
8	27½ × 12 × 2¾	0.53	33

If the proper centre of gravity is maintained, the overall weight of the additional equipment can be as much as 330 lb. Compartments 1 and 2 can house radar augmenters, 3 and 4 instruments, 5 main parachute, 6 instruments, 7 brake chute, and 8 the air bag.



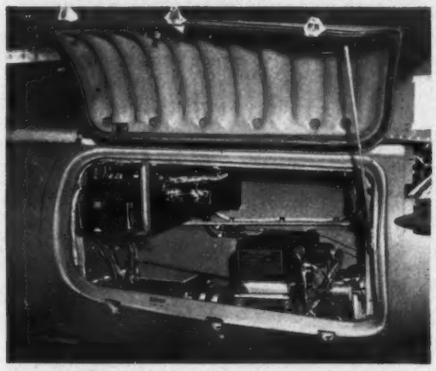


Sectioned drawing of the Ryan Q-2C *Firebee*.

1 – scoring system
2 – battery
3 – engine
4 – fuel tank
5 – aileron servo
6 – flight control box
7 – augmentation equipment
8 – telemetry system
9 – radio control receiver
10 – S-band beacon
11 – elevator servo
12 – parachute compartments

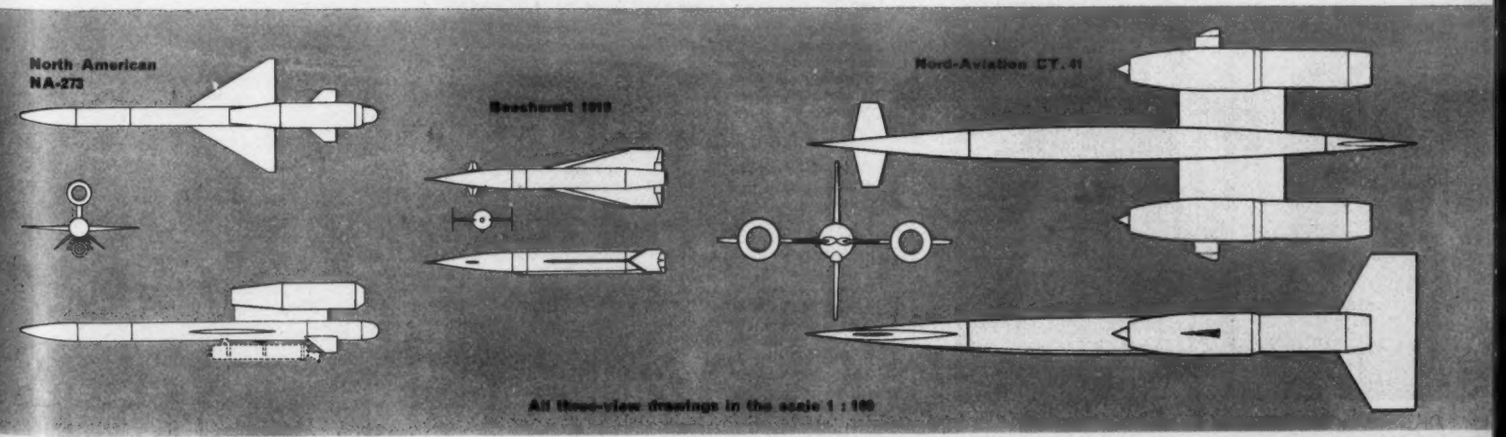
The target drone has one more important task, the recording of hits by miss distance indication; this can be done both optically and electronically. (Acoustic hit indicators are used mainly in towed targets; SAAB produces an equipment of this kind under the designation BT13). The *Jindivik* is an example of a drone with optical miss distance indication. Earlier versions carried a number of cameras in their Mk.2 Ampor wing-mounted nacelles, which could photograph guided missiles over a wide angle of vision. Today, Mk.4 nacelles are used, each with two Wretar cameras with a viewing angle of 186°. The Wretar camera is a joint development of the Australian Weapons Research Establishment and Fairey Australasia.

A number of systems have been developed for electronic hit recording, including the Aerojet-General Ordnance Engineering Division's FIRETRAC (Firing Error Trajectory Recorder and Computer) and the Aircraft Armaments Inc. MDM (Miss Distance Measuring) system. The MATTS (Multiple Airborne Target Tracking System), developed by the Cubic Corporation, enables two target drones to be tracked simultaneously. The signals of the transmitter carried by each drone, which are spaced by 1 Mc/s, are received by two ground stations, so that the positions of the targets can be accurately determined. The information from the two stations is sent to a third, which tracks the attacking missile by radar and uses a computer to determine the distance between target and attacker at the time of the missile burst. A hit is recorded when an attacking weapon comes within a certain range of the target; this so-called "lethal" range depends on the weapon's explosive force.

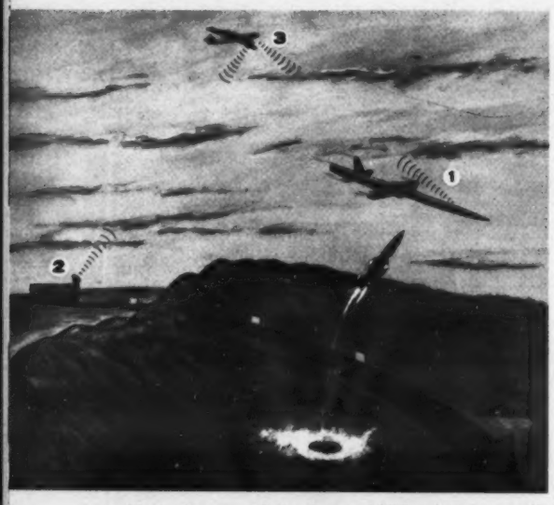


The electronic equipment compartment in the fuselage rear of the Q-2C. Left, the Lear autopilot; centre, telemetry equipment; right, radio command receiver and decoder. All the equipment is mounted on rails, enabling it to be easily slid out for maintenance.

Finally, the PARAMI (Parsons Active Ring-Around Miss Indicator), developed by the Ralph M. Parsons Company, comprises a transponder carried by the drone and a considerably weaker transponder in the attacking weapon. Two radio links of different carrier frequencies form a "bridge" between the two transponders and enable distance to be determined in the following way: The drone transmits a signal on 265 Mc/s, which is received by the missile and returned on a frequency of 324 Mc/s; the drone then converts the signal to the original

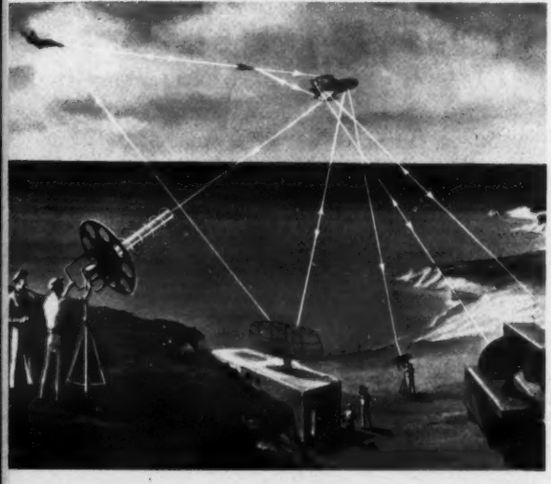


Drawing showing how large targets are simulated by radar augmenters. The Lockheed Q-5 *Kingfisher* shown in the picture produces an echo of the size of a Convair B-58 *Hustler* on the radar screens of fighters or guided missile batteries.



Block diagram of the Sperry MCG microwave radio guidance system. 1 – target drone; 2 – ground command station; 3 – airborne relay station.

A *Firebee* mission. Lower right, radio guidance system for the drone, here used as a target for a missile with radar homing head; centre, a surveillance radar to monitor the entire practice mission; the two directional antennas, which are slewed by hand, are part of the PARAMI scoring system described in the text.



265 Mc/s frequency. This process is repeated continuously; the two transponders are, so to speak, linked by a "ring-around" frequency, which increases as the distance between them lessens, and decreases as it grows. The distance is recorded directly on a paper strip, so that the results of the mission can be read off seconds after the interception.

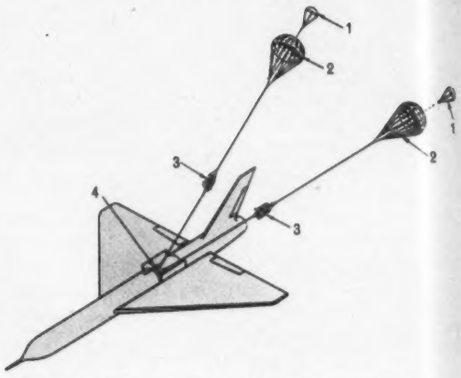
The Temco *Teal* emits flashes when a missile fired at it comes within "lethal" range.

. . . and reconnaissance

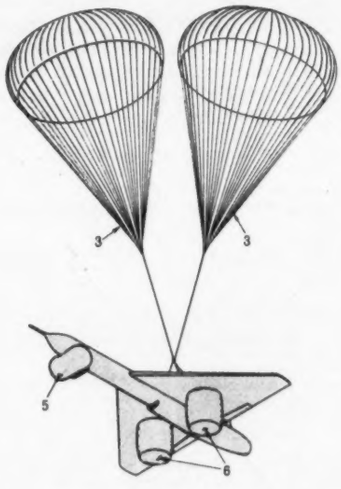
Among the tasks of reconnaissance drones are the recording of changes in the front line situation, the detection of potential targets and the transmission of their coordinates, the detection of nuclear explosions on the battlefield and the supply of information on weather and terrain. The special equipment which they carry is correspondingly varied, ranging from aerial cameras, cine cameras, television, infra-red and radar equipment to meteorological instruments.

For aerial cameras, large formats (9 × 9 or 70 mm roll film), high-resolution lenses and special filters and films are used. Exposure times are determined with the aid of a programme equipment or by radio command from the ground. Among the manufacturers of such cameras are the Chicago Aerial Corporation and the British firm of W. Vinten Limited.

The Motorola Military Electronics Division has developed a side-looking radar for the Aerojet-General AN/USD-2. The exceptionally high discrimination of this equipment



Recovery device for the Fairchild AN/USD-5. Upper picture: The two auxiliary parachutes (1) cause the brake parachute (2) to unfold; this in its turn opens the main parachutes, still packed. All parachutes are housed in the fuselage centre section (4). The lower picture shows the unfolded main parachutes (3) and the nose and wing air bags (5 and 6) which absorb the landing shock.



Remote-Controlled Aircraft as Targets

Early this year, Short Brothers & Harland Limited received a contract to supply further remote-controlled English Electric *Canberra U.Mk.10* aircraft to the Royal Navy, which would operate them from Malta as targets for guided missiles of the British Mediterranean Fleet. In the United States, too, Lockheed is converting 24 *Starfighters* to QF-104 target drones. In short, aircraft are not letting missiles do all the work of representing targets. They have the advantage of being realistic targets; what is more, the two examples named have very high performances. Among other aircraft types being used as target drones are the Fairey *Firefly U.Mk.8* and Gloster *Meteor U.Mk.16* in Great Britain, and the Boeing QB-47E in the USA. Information on all the aircraft mentioned is given below.

Fairey *Firefly U.Mk.8:* a conversion of the three-seat *Firefly A.S.Mk.7;* radio command guidance; cameras for indicating miss distance; power-plant one 1,965 h.p. Rolls-Royce *Griffon 74* piston engine; gross weight 14,000 lb; maximum speed 225 m.p.h.; endurance 180 minutes. Converted two-seat *Firefly Mk.5* aircraft bear the designation *Firefly U.Mk.9.*

Gloster *Meteor U.Mk.16:* a *Meteor F.Mk.8* fighter converted by Flight Refuelling Limited (modified *Meteor F.Mk.4s* bear the designation *Meteor U.Mk.15*). Radio command guidance from the ground or from aircraft; cameras to provide miss distance information are housed in wing-tip pods. The drone is powered by two Rolls-Royce *Derwent 8* jets, each delivering 3,500 thrust. Span 37 ft 2 in.; length 43 ft 6 in.; gross weight 14,000 lb; maximum speed 500 m.p.h.; operating altitude 40,000 ft; endurance 90 minutes.

English Electric *Canberra U.Mk.10: Canberra B.Mk.2* bomber converted by Short. Radio command guidance; automatic actuators for air brakes and landing flaps, undercarriage and brake chute; automatic navigation and miss distance recording equipment etc. *Canberra U.Mk.10s* have repeatedly flown fully automatically at altitudes of over 50,000 ft. Powered by two Rolls Royce *Avon* jet engines, each of 6,500 lb thrust, the drone reaches a speed of 500 m.p.h. Operating altitude is 52,000 ft, and endurance is quoted as 240 minutes. Span 64 ft; all-up weight 40,000 lb.

Boeing QB-47E: conversion of RB-47 long-range reconnaissance aircraft by Lockheed Aircraft Company, Georgia Division; first flight in spring, 1959. Sperry radio command guidance system; fitted with arrester hook for landing; used primarily as a target for Boeing *Bomarc* surface-to-air missiles. Six General Electric J47-GE-25 engines, each delivering 7,200 lb thrust. Span 116 ft; all-up weight 175,000 lb; maximum speed 550 m.p.h.; operating altitude 40,000 ft; endurance 330 minutes. Guidance for take-off and landing, and over the practice range, is conducted from the ground; for the remainder of the time, a "pilot" in an accompanying Lockheed DT-33 controls the QB-47E.

Lockheed QF-104: a conversion of the F-104A interceptor. Radio command guidance from the ground and from Lockheed DT-33s. If radio connections fail, the QF-104 will automatically maintain an altitude of 20,000 ft. Powered by a General Electric J79-GE-3A, it reaches a maximum speed of 1,450 m.p.h. operating altitude 50,000 ft; endurance 30 minutes. Span 21 ft 11 in.; length 54 ft 9 in.; all-up weight 17,000 lb.

enables it to draw maps at speeds of up to Mach 1 and to detect targets moving on the ground. The radar presentation is photographed on a film which is synchronized with the speed of the drone.

Even the most accurate reconnaissance systems are, however, useless unless the information can be passed rapidly to command posts. Equipment has therefore been developed for the radio transmission of photographs. With the Fairchild Photo Transmission System, photographs are developed in the drone itself. The negatives are scanned by optical-mechanical devices, the light pulses then being converted into electrical signals and transmitted to the ground station by a microwave communication channel. The signals are then reconverted to light pulses by demodulation, and the pulses reproduce the original picture on a storage tube. A transparency from a 70 mm film with a discrimination of 40 lines per millimetre is available less than 2 minutes after the original photograph was taken. A similar procedure for the transmission of aerial photographs, the Photoscan system developed by CBS Laboratories, Stamford, Connecticut, was described in *Interavia*, No. 6/1960, page 734.

The Chance Vought KD2U-1, a converted *Regulus 2*, begins its flight with the aid of a solid-propellant rocket of 130,000 lb thrust; it lands on a normal nose-wheel undercarriage. KD2U-1s are used at Eglin Air Force Base, Florida, to test Boeing *Bomarcs;* they are also in service with the U.S. Navy as targets for the Philco *Sidewinder*, the Raytheon *Sparrow* and the Convair *Terrier*.

Recovery

On completion of their missions, the drones return to their bases. They must now be brought back to earth undamaged, so that they can be used again and the information which has not been transmitted by radio can be retreived. Little information has been published regarding the number of missions which a drone can perform. All that is known is that *Jindiviks* have averaged twenty missions, and on occasion have even been known to complete forty. An average life of fourteen missions has been quoted for the Ryan *Firebee*.

While the *Jindivik* is fitted with a skid and the KD2U-1 has a normal nose-wheel undercarriage, most drones land by parachute, the main parachute opening only when the brake chute has decelerated the drone to an acceptable speed. For example, the 40 ft main parachute of the Beech 1025 reduced the rate of descent to between 18 and 22 ft/sec. The landing shock is in many cases mitigated by air bags, which, housed in fuselage and wings, are inflated before landing. The Lockheed Q-5, on the other hand, digs its long, pointed nose vertically into the ground. The North American NA-273, which lands horizontally, automatically extends a pair of mechanical feelers; as soon as one of these touches the ground, it fires a retro-rocket. The parachute is released on landing, so that the drone is not dragged along the ground and damaged in a high wind.

It often happens that a drone lands on water. This possibility, too, has been provided for by making the drone capable of floating, e.g., by filling the free space with foam. This problem can be solved relatively simply. A more difficult problem is to ensure that instruments, equipment and components are watertight, quite apart from other stringent requirements. Here, the elevator and aileron servo actuators developed by Lear Inc. for the Ryan Q-2C should be mentioned. They are not only watertight, but can withstand vibrations of up to 15 cycles per second and the pressure increase during their descent from 60,000 ft to sea level at a rate of 3,000 ft/min. In addition, they remain unaffected by impact on water and by rapid cooling.

This fuselage mockup was built to test the recovery mechanism of the Republic AN/USD-4 *Swallow* reconnaissance drone. It was placed on a rocket sled, and the main parachute ejection device was tested at speeds of between 200 and 300 m.p.h. After three years' work, on which $34 million were spent, development of the drone has been cancelled in favour of the Fairchild AN/USD-5.

In reviewing the ranks of small drones, one has the impression that nearly every air defence weapon requires a target drone tailored to its needs. The number of reconnaissance drones for different tasks is continually on the increase, as defence forces re-equip with tactical missiles and atomic warheads. Whether the tendency towards specialization will increase, or whether a measure of standardization will be achieved, remains to be seen. In the present article, many details deserved to be treated at greater length. The editors would have liked to say more about certain projects still at the development stage—if the manufacturers and the military authorities were not quite so taciturn. In any case, there is always the consolation that the columns of *Interavia* will continue to remain open for articles on drones for all kinds of missions. ↔

SAAC.23 Execujet

A Joint European-American Project

That modern business aircraft not only cost money, but also help to save it, is evident from the increasing numbers of these aircraft being placed in service in the USA. Business flyers log no less than 5 million flight hours a year, compared with a bare 4 million for scheduled air transport. And that the market for business aircraft is by no means exhausted is proved by the growing number of models in this class on offer, ranging from the small single-engine four-seat tourer to the 15-ton, multi-engine long-range turboprop or jet aircraft costing upwards of a million dollars. Aircraft in this price bracket are, of course, within the means of only a very limited number of large concerns, and even then are seldom fully utilized. A survey of business flying in the USA reveals that 80% of all flights are made by aircraft carrying four occupants or less, and that 80% of all air trips are shorter than 800 miles.

The medium-range jet business aircraft is therefore of special interest. For its compact engines enable it to be made smaller and lighter than more conventional business aircraft with the same transport capacity, not to mention the considerably higher cruising speed. In a jet aircraft a journey can be made in half the time required by a piston-engine aircraft, thus eliminating the need for the additional aircraft and cabin equipment which would be required on four- or five-hour flights. The modern medium-range business aircraft is thus no longer a flying office where travelling time is used to get through any work that needs to be done, but purely a fast means of transporting the businessman to his next conference. Passengers can travel to their destination in one or two hours in comfort equivalent to that of a large touring car.

*

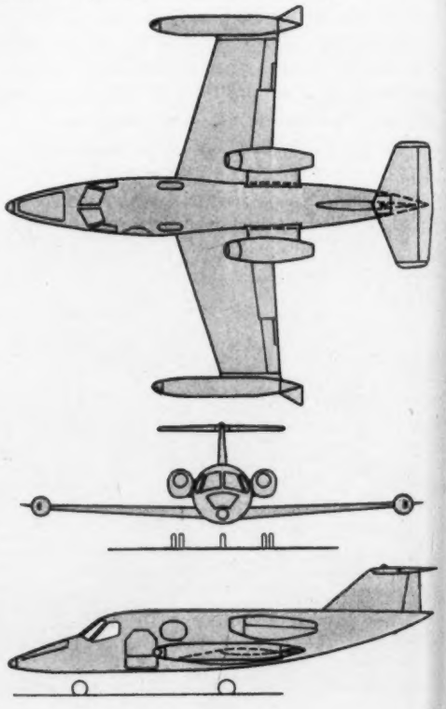
Starting from these considerations, the American industrialist William P. Lear Sr. has decided to develop a twin-jet business aircraft for ranges of up to 2,200 miles, which he intends to offer on the international market under completely new conditions. In April, 1960, Lear founded the Swiss American Aviation Corporation in Wilmington, Delaware, which is to undertake development of the new aircraft in close collaboration with Aviation Development Corp. of St. Gallen (share capital Sfr. 500,000 = $113,425) and later act as project coordinator for the production version. In October, 1960, discussions were held between representatives of the Swiss Federal Air Office, the Swiss American Aviation Corp. (SAAC) and the American Federal Aviation Agency, and it was decided to carry out advance type certification of the jet aircraft, known as SAAC.23 *Execujet*, for the European and American markets. The SAAC.23 is a low-wing aircraft with two jet engines (probably General Electric CJ610-2Bs) mounted at the sides of the fuselage, and will carry six to seven passengers over a range of more than 1,700 n.m. at altitudes of 33,000 to 40,000 ft and a cruising speed of 430 knots.

As William P. Lear Sr. announced at a press conference in Geneva, SAAC intends to offer the aircraft in 1963 at an estimated price of $250,000 (without radio, radar, automatic pilot and certain internal installations). The first flight will be made in April or May, 1962; type certification in accordance with FAA requirements for aircraft in the 12,500 lb class, for flying by non-professional private pilots without co-pilot, should follow in August of the same year. The first production models are scheduled to roll off the assembly line in early 1963. Although it has not yet been decided where the aircraft are to be assembled, this will certainly be in the USA—probably by a subcontractor. It is planned to build 75 aircraft in 1963 and about 100 in 1964. In the following three years it is hoped to raise the production rate from 125 to 175 or 200 aircraft a year.

Some 40% of the components will be manufactured outside the United States, and the prototype is to be built by Aviation Development Corp., St. Gallen. Flug- und Fahrzeugwerke AG, of Altenrhein, Switzerland, is expected to produce certain parts of the wings and fuselage. In February, William P. Lear Sr. had talks with representatives of Mitsubishi Heavy Industries in Japan regarding the likelihood of the firm's cooperation in the SAAC.23 programme. It is possible that the undercarriage may be produced in Japan.

In the meantime, Aviation Development Corporation and SAAC have published further details of the projected business aircraft. The SAAC.23 is to have a presssurized cabin, and the fuselage nose, which will house the electronic equipment and some of the electrical systems, will also be pressurized. The fuselage nose is so designed that a sudden loss of pressure does not affect the pressure in the cabin. The fuselage configuration and the layout of the main systems can be seen from the accompanying cutaway drawing. Behind the passenger seats, near the centre of gravity, is a baggage compartment with a

Three-view drawing of the SAAC.23 *Execujet*.



capacity of 69 cu.ft.; when the rear passenger seat is folded, the available baggage space is increased to 95 cu.ft. Directly behind the pressure cabin, roughly level with the wing leading edge, are the ventilation and air conditioning systems, the aircraft batteries, voltage regulators and fuel system valves.

The wing is similar to that of the P-16 single-seat combat aircraft developed by Flug- und Fahrzeugwerke AG Altenrhein. When the landing flaps are actuated, the ailerons are deflected downwards by 20°. The flaps themselves are in three sections on each wing and move through 60° to the fully down position.

The installation of the engines at each side of the fuselage rear and above the wings offers a number of advantages, including improved protection of the engines during wheels-up landings and reduced risk of the ingestion of foreign bodies. Even the earliest designs made provision for the installation of high-performance turbojets with thrust reversers, eliminating the need for subsequent structural changes.

According to current General Electric specifications, the overhaul life of the CJ610-2B (with a standard thrust of 2,400 lb) is 1,000 hours. As an alternative solution, the installation of two Continental J69 jets, each with a thrust of about 1,700 lb thrust, has been considered.

The entire fuel supply is carried in wing or wing-tip tanks, and the fuel feed system is extremely simple. Undercarriage, flaps, de-icing system etc. are hydraulically actuated.

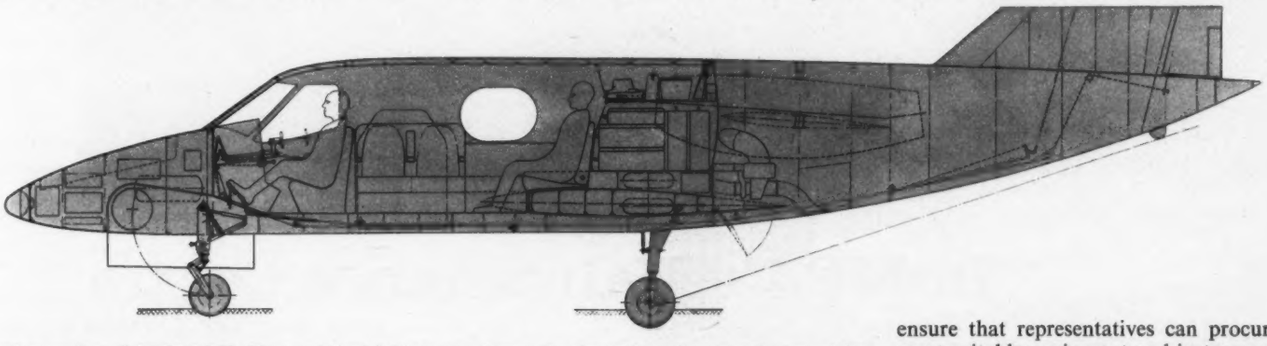
Dimensions, weights and performance data are listed in the accompanying box, from which the short take-off and landing distances and high cruising speed will be noted. Take-off and landing distances of less than 5,000 ft (at airfields over 5,000 ft above sea level) are indeed remarkable for an aircraft of the SAAC.23's speed class. The *Execujet* also meets FAA requirements for engine-out take-off; single-engine cruising speed is over 350 knots.

*

William P. Lear Sr. stresses that the Swiss American Aviation Corporation will not sell the aircraft itself, but will entrust sales representation, the installation of aircraft equipment, maintenance and repair work and the supply of spares to a number of other companies. In this way it should be possible to keep the selling price highly flexible, and to ensure that representatives can procure the most suitable equipment and instruments for their respective markets and organize installation and customer service to suit local requirements. The rebate normally granted to aircraft manufacturers on purchase of a given piece of equipment will in this way be received by the distributor. Despite the freedom of action which the sales agents are allowed, Lear recommends the installation of duplicate ADF and duplicate VHF navigation and ILS equipment, as well as an additional VHF transmitter/receiver and a VHF auxiliary transmitter. The pressurized fuselage nose has adequate space to house all this equipment. Even with this equipment, it is hoped to keep the price of a fully equipped SAAC.23 down to $325,000. The manufacturer will, of course, procure suitable equipment for the prototype, and the equipment used in type certification tests will no doubt be of a type likely to meet customers' wishes.

The *Execujet* also has military possibilities, such as special training, communications flights near the front line, photo reconnaissance, ambulance services and decoy flights to saturate enemy radar warning systems. Here it is interesting to note that Lear engaged Gordon Israel, designer of the Grumman F7F *Tigercat* and F9F *Panther*, as chief adviser for the *Execujet* programme. Israel has also worked as Chief Engineer for Lear at Santa Monica, where he was responsible for developing the *Learstar* business aircraft.

Doubtless, as its original name implies, Lear has tailored his business aircraft first and foremost for the American market. But the innovations in the Swiss American Aviation Corporation's design and sales policy should not be without their attractions for customers in other countries. ←→



Fuselage section of the SAAC.23. The pressurized fuselage nose houses the electronic equipment and some of the electrical systems. Nose-wheel and main undercarriages retract into the fuselage. The wing consists of a seven-spar box, whose upper and lower sides are each in the form of tapered rolled sheets. Each wing contains three integral fuel tanks. Set obliquely above the air conditioning and ventilating system in the rear fuselage is the pylon for the two engine pods (with front spar and double T main spar). The complete horizontal tailplane (not visible in picture) can be moved to trim the aircraft about its pitch axis.

Data for the SAAC.23

Powerplant

2 General Electric CJ610-2B jet engines, each of 2,400 lb thrust

Dimensions

Span	34 ft 7.4 in.
Length	37 ft 4.6 in.
Overall height	10 ft 10.7 in.
Track width	8 ft
Wheel base	12 ft 9 in.
Max. cabin inside diameter	4 ft 10 in.
Wing area	215 sq.ft.

Weights

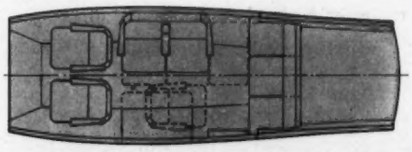
Empty weight	5,150 lb
Max. payload, consisting of pilot, passenger or co-pilot, five further passengers and baggage	1,450 lb
Fuel load	4,600 lb
Max. take-off weight	11,200 lb
Wing loading	52.1 lb/sq.ft.

Design flight performance*

Max. true air speed at 10,000 ft	approx. 520 knots
Max. Mach No.	approx. 0.85
Cruising true air speed at 30,000 ft at max. continuous thrust	430 + knots
Economical cruising speed at 40,000 ft	400 knots
at 30,000 ft	380 knots
Sea level rate of climb at max. gross weight	6,000 ft/min
Service ceiling	over 40,000 ft
Max. range at 40,000 ft with full fuel and reserves for 45 min holding time	1,740 n.m.
CAR take-off distance over 50 ft obstacle (at max. gross weight and sea level)	4,200 ft
CAR landing distance over 50 ft obstacle (at 8,900 lb weight and sea level)	2,500 ft

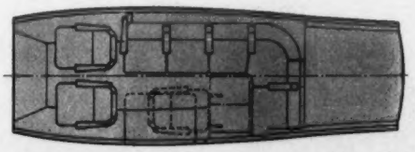
* Performance data are quoted for ISA conditions and are based on engine data published by General Electric in December, 1960.

Cabin layouts

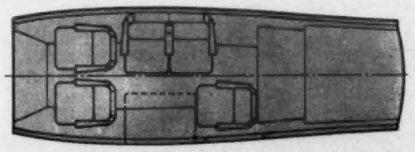


Six- to seven-passenger layout with 260 lb baggage.

Six-passenger layout with 260 lb baggage.



Layout for six to seven passengers (with angled bench) and 260 lb baggage.



Layout for four passengers and 570 lb baggage.

In MEA's Maintenance Centre

Middle East Airlines (MEA), a company with its headquarters in the capital of the small neutral State of the Lebanon, operates scheduled passenger services from Beirut to Europe—London, Geneva, Rome, Athens, Frankfurt, Vienna and Istanbul—and all the major cities of the Middle East. It also runs highly profitable freight services between the European cities mentioned and a number of Middle Eastern economic centres, including Teheran, Baghdad, Kuwait and Dhahran. The airline, which is a member of the International Air Transport Association, is 51% privately owned by Lebanese, the remaining 49% being held by the British Overseas Airways Corporation. The present fleet comprises four *Comet 4Cs*, six *Viscount 700s*, and three DC-3s. It thus has a transport capacity of approximately 500 million seat miles a year with a daily aircraft utilization rate of seven hours; when the aim of nine hours' utilization is achieved, the figure will, of course, increase accordingly.

Although MEA has to share its passenger services with two other Lebanese and well over a score of foreign operators, it has been making profits regularly over the past few years. It has worked this economic wonder by holding firmly to the principle that only the best will do in air transport: punctuality in operations; a rational route network with well-chosen aircraft; and superlative cabin service by trained personnel with fluent command of Arabic, English and French, the three languages in current use in the Middle East. MEA aircraft are piloted almost entirely by highly qualified British, Canadian and Australian pilots—at the present time there are some 65 of them—until properly trained Lebanese flight personnel become available.

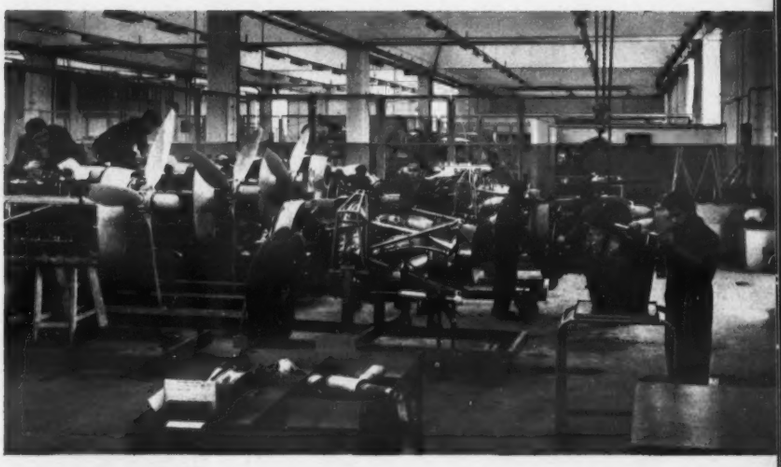
However high the quality of the flight personnel and the commercial services, even the best-laid flight plans can come to naught unless a well-run central maintenance and repair shop is available to ensure that aircraft can always be operated on schedule. The MEA maintenance centre, located at Beirut International Airport, employs over 1,000 personnel, has the most modern equipment and is organized down to the smallest detail. Operating independently for some years under the name MASCO (Mideast Aircraft Service Company), it is now wholly owned by MEA. Here are serviced not only all of MEA's aircraft, but most of the aircraft (chiefly *Viscounts*) of other Middle Eastern operators—among them Aden Airways, Ariana Afghan Airlines, Iranair, Iraqi Airways, Kuwait Airways—and the fighters and communications aircraft of the Lebanese Air Force. Apart from ensuring a more even work load on the installations, cooperation with other companies results in substantial reductions in the cost of spares.

The visitor to the maintenance centre is struck first of all by its spaciousness. At

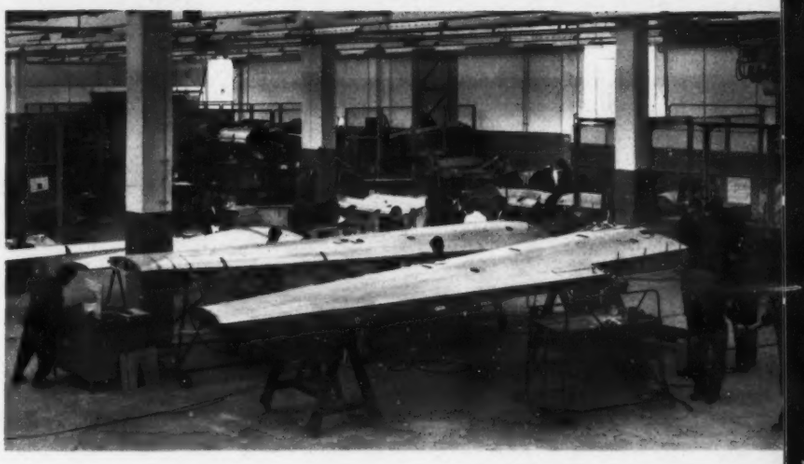
The repair and testing of the *Viscount's* variable pitch propellers require expensive special installations. In addition to the regulating equipment illustrated there are a measuring device for propeller blade contours and a propeller balancing rig.

present, it covers an area of some 330,000 sq. ft., but this is to be doubled in the near future. In the two large final assembly halls, the components repair workshops, the electronics and equipment shops, the storerooms where components await repair, the test facilities and sub-stores, there are generous working surfaces and ample room for movement, important considerations for rational working conditions. No less imposing is the number of test stands and assembly jigs bought from abroad and indispensable for the proper servicing of the Rotol propellers and control systems, and the undercarriage and hydraulic systems of the *Viscount*. In addition to these, a number of simpler test stands and ground servicing facilities have been built by the company itself. Large coloured monitoring panels for items such as the aircraft electrical system and the electronic parts show at a glance the progress of work on any aircraft.

Emile Nasrallah, the company's Sales Contracts Manager, gives the following interesting information: As is usual in modern air transport, all overhaul work which must be carried out during the life of an aircraft is divided into a series of precisely defined, periodically recurrent "packages." In the case of the *Viscount* there are four kinds of check and overhaul programmes: Check 1 is carried out every 125 flight hours, unless another check has intervened, such as Check 2 (every 375 hours), Check 3 (every 750 hours) or Check 4 (every 1,500 hours). In addition, routine checks (A and B) are made after each flight. While Check 1 can be made overnight, Checks 2 and 3 mean that the aircraft is out of commission for 24 hours or four to five days respectively. Finally, Check 4, which is made every 1,500 hours, requires two weeks and is, if possible, arranged for slack periods of the year, being made twice annually at the most.



Assembly of Rolls-Royce *Dart* propeller turbines (centre) and de Havilland *Gipsy Queen* piston engines.



General overhaul of the wings of a de Havilland *Dove* in one of the workshops of the maintenance centre.

Test room for Ekco airborne radar (antenna unit in background), which enables MEA's *Comets* and *Viscounts* to skirt storms and aids pilots in navigating over coastal regions in bad weather.

Overhaul work on a Kuwait Airways *Viscount* has been completed, and final checks are now being made.

During each major check the components and equipment, dismantled, cleaned and accompanied by a service report, are kept in store until labour and facilities are available for their repair and all the necessary materials are on hand. In other words, they are not issued for repair until they are ready to be dealt with. After repair, they are handed over to production control, which is completely separate from the workshops; here they are again tested, cleared and sent to the ready store.

The workshops normally work an eight-hour day, but the assembly halls work in three shifts. Each hall can accommodate up to six aircraft the size of a *Viscount* and is equipped with a network of under-floor compressed air connections and electric power points.

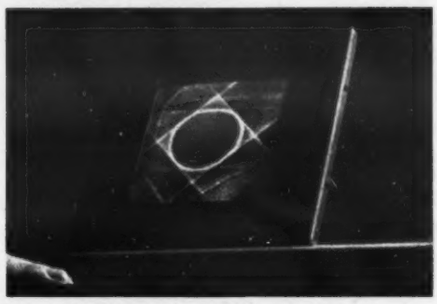
Although MEA maintains all its aircraft equipment, including radar and propellers, in its own workshops, it does not—as had originally been planned—overhaul the turbine engines. It restricts itself to the refitting of overhauled engines into power packs for use as replacements as occasion arises. This is because the long overhaul lives of the *Dart* (3,000 hours) and *Avon* (2,000 hours) make it more economical to remove them during scheduled night stops at London Airport and hand them over to Rolls-Royce, the manufacturers, for overhaul. ⟶

Electronics in Aviation and Industry

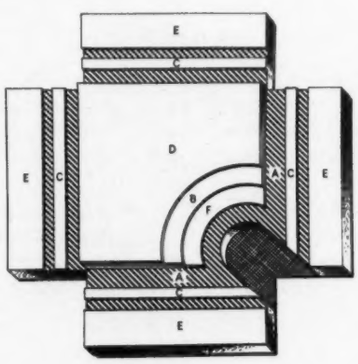
• **Hughes Aircraft Company, Culver City, Calif.,** announces a radar using a coherent light beam in place of the normal microwave pulses. The new equipment has been named Colidar (Coherent Light Detection and Ranging) and represents the first practical application of the Laser (Light Amplification by Stimulated Emission of Radiation) system, developed by Hughes in 1960. The Laser serves as transmitter for the Colidar.

The main component of the Laser (A) is a ruby crystal 3/8 in. in diameter and 1½ in. long, which when excited produces a sharp, monochromatic beam with a wavelength of 6,943 Ångström. The beam generated has a width of 0.7°, and this is made even sharper (0.023°) by a small telescope. Radiated at a peak power of 2,000 watts and reflected by fixed objects, the pulses are picked up by a concave reflector as in a normal telescope (B) and then fed to a photo cell by a red filter; the signal is further amplified and processed in a conventional manner.

The exceptionally narrow beamwidth gives the Colidar high resolution. On clear days it is possible to distinguish between two objects only ten feet wide lying side by side at distances of 5 or 6 miles. Range is, however, limited owing to attenuation of radiation by the atmosphere. The advantages of the Colidar's exceptional performance are therefore most likely to find application in outer space, where long distances can be bridged at relatively low transmission power.



• **General Telephone & Electronics Laboratories, Inc., New York,** a subsidiary of General Telephone & Electronics Corporation, has exhibited at the International Convention of the Institute of Radio Engineers in New York a compact, panel-type screen on which moving light signals can be displayed. The company has so far been reticent in assessing the practical applications of this development, but stresses the advantages of the screen, which is less than half an inch thick, over conventional cathode ray tubes.



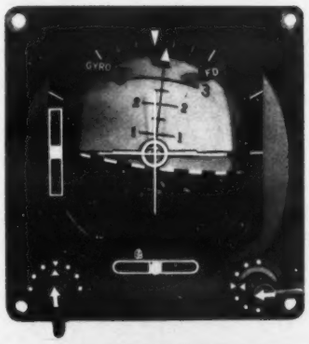
The screen consists of a piezoelectric ceramic panel (A), coated with a thin layer of electroluminescent material (B). If the electrodes around the rim of the panel (C) are fed with electric pulses, sound waves are propagated over the ceramic panel. The piezo effect converts the sound (= pressure) waves on the surface of the panel into electric charges, which cause the appropriate areas of the electroluminescent layer to glow. By varying the pulses emitted by the exciter electrodes, the position of the bright spot can be shifted; its brightness can be regulated by altering the electrical voltage provided by a transparent surface electrode (D). The absorbers (E) capture the unwanted sound waves propagated in the direction of the rim of the panel; finally, a non-linear resistance (F) serves to mitigate scattered light in certain cases.

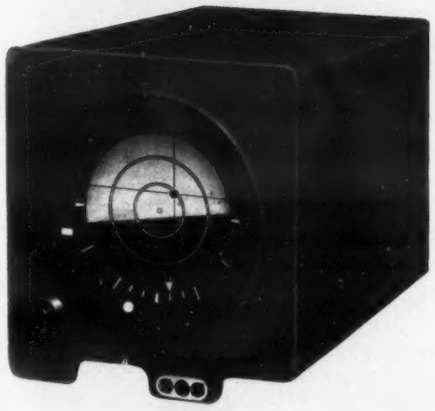
• **The Cincinnati Division of Bendix Corporation, Cincinnati, Ohio,** has delivered two complete electronic safety systems to measure, log and monitor tests during the development phases of nuclear reactors which will be used to supply auxiliary power in space vehicles. The tests are being conducted by Atomics International Division of North American Aviation under the Atomic Energy Commission's SNAP (Systems for Nuclear Auxiliary Power) programme. Bendix has already delivered a number of similar safety systems, including a system for the reactor of the U.S. Navy's first nuclear-powered destroyer.

• **The Industrial Components Division of Raytheon Company, Newton, Mass.,** reports the development of nine standard models (WM-101 to WM-109) of WELD-PAK logic circuits for direct plug-in substitution in transistorized computer circuits. The modules measure 1″ by 0.75″ by less than 3/8″ and are guaranteed to operate reliably at temperatures between − 55 °C and + 55 °C.

• **The Computer Systems Laboratory of Litton Systems Inc., Woodland Hills, Calif.,** is now offering the *Deci-Line* direct digital reader on the civil market; the equipment is already in use in a number of military systems. *Deci-Line* assemblies are supplied with three, four, five, and six digits, and have small dimensions and low weight. They work satisfactorily at temperatures between − 30 °C and + 95 °C, can withstand shocks up to 15 g and 5 to 500 c/s vibration at up to 10 g.

• **Sperry Gyroscope Company, Brentford, Middlesex,** has developed, in close collaboration with the BEA Helicopter Experimental Unit, two new instruments which represent a great step forward in helicopter instrumentation for all-weather flying. First, as an interim measure, a zero reader has been developed, with two additional director indices: at the left is a rectangular marker to indicate collective pitch, at the bottom a circular marker to indicate yaw. Two trim knobs at the lower corners of the instrument zero the pitch and roll directors. From this equipment an instrument has been developed, which indicates the attitude





of the helicopter in the form of a calibrated sphere. In front of the sphere move the two white arms of the crosspointer (covering the zero in the picture). At the left and bottom of the instrument respectively are collective pitch and yaw markers. Another solution to the problem is offered by the instrument in the cower picture. Attitude here is indicated not by a sphere, but by a flat, roller-blind type system, the separation between black and white representing the horizon as in the previous instrument; the circles engraved on the glass front enable a more accurate reading to be taken. The crosspointer is replaced by a black ball whose movements are controlled by thin, barely visible wires. Among the advantages of this type of presentation is that it is less subject to parallax error than the sphere.

• **The Computer Systems Laboratory of Litton Systems Inc., Woodland Hills, Calif.,** *Calif.*, offers a magnetic storage drum, which is already in usea in military aircraft, guided missiles and ground installations. The body of the drum, which is cast from light magnesium, is coated with a thin layer of nickel-cobalt alloy, which provides the storage medium. On the mirror-like surface of this are mounted the read/write heads, which directly contact the drum until it reaches its operating rotation speed; they then rise a few millionths of an inch from the surface. This combines the advantage of the high efficiency obtainable with contact read/write heads, with that of the long life of magnetic drums whose heads are mounted at some distance from the rotating surface.

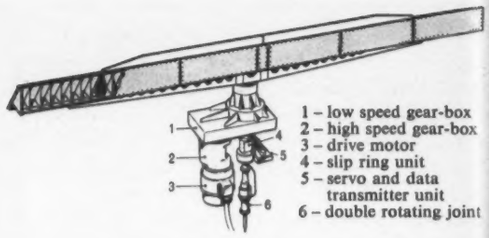
• **Radio Corporation of America, New York,** reported briefly, during the Institute of Radio Engineers Convention in New York, on a new system using colour television techniques for the presentation of data. The system requires no additional equipment such as television cameras, as it can take data directly from compatible computers, radars or data processing system. The data are displayed on a cathode ray tube, with different types of data being presented in different colours. Data from remote sources can be handled by cable or radio circuits. The system is suitable for a wide variety of civil and military applications, including air traffic control. This was demonstrated by RCA during the Convention, when echoes of aircraft flying at different altitudes picked up by radar appeared in different colours on the screen. The air traffic controller can thus tell at a glance when two aircraft flying at the same altitude are getting too close, and can instruct one of the pilots to make the necessary alterations in heading.

• **Marconi's Wireless Telegraph Company Ltd., Chelmsford, Essex,** manufactures high-precision, ultra-stable quartz oscillators—with a tolerance of less than 1 in 10^9 over several hours of operation—which are being used in the airborne test equipment for a new VLF radio navigation system. The tests are being carried out by the Royal Aircraft Establishment, Farnborough, with the aim of developing an accurate, continuously operating long-range navigation system using only a few ground stations. In recent flight tests with a *Comet*, the use of the Marconi oscillators reduced the navigation error to some 2 miles at a distance of 3,000 miles. Marconi is at present carrying out miniaturization work to reduce the size and weight of the oscillators.

• **Ultra Electronics Ltd., London,** has sole rights for the licence production of a new Crash Position Indicator (CPI), which is automatically released from an aircraft after a crash or forced landing and transmits radio signals which can be picked up by search aircraft with standard equipment at distances of up to 40 miles. The transmitter is housed in a foam plastic shell (dimensions 20 × 20 × 4½ in.) attached to the outer surface of the aircraft. This falls to earth in a shallow curve, with a relatively soft impact. The CPI has an independent power supply for an operating life of 100 hours and has a flat metal disk as an antenna. Experiments in woods, in deep snow and on water have shown that the equipment operates excellently even under the most difficult conditions. In 1959 the four engineers of the Canadian National Research Council who developed the indicator received the Brabazon Prize offered annually by the British Institution of Radio Engineers for the best contribution to flight safety described in its publication.

Secondary Radar

By D.H.R.Archer, M.A., Cossor Radar & Electronics Ltd., Harlow


1 – low speed gear-box
2 – high speed gear-box
3 – drive motor
4 – slip ring unit
5 – servo and data transmitter unit
6 – double rotating joint

Antenna of the Cossor S.S.R.4G secondary radar ground installation.

The way now seems clear for the world-wide adoption of secondary surveillance radar. The Air Traffic Control Radar Beacon System (ATCRBS), agreed by ICAO in 1957, was delayed in implementation on account of the modifications desired by the USA. However, discussions between the U.K. and USA authorities, these being the two countries responsible for most of the development work, led early this year to a compromise agreement which will, it is expected, be accepted by other nations.

Very little ground equipment meeting the full ICAO (or compromise) requirements has so far been installed, but substantial installation programmes are planned in several countries. In the USA there is an operating system using earlier equipment, and over much of the country high-flying aircraft must carry transponders. Similar regulations will be imposed in the near future in the U.K., where London Airport already has a ground installation to ICAO recommendations. Because of these requirements many turbojet aircraft operating over North American routes already carry transponders, and installation programmes for turboprop aircraft are not far behind.

In terms of the number of countries involved, therefore, the airborne installation programme is well ahead of the ground programme. Any degree of implementation is a welcome contribution to air safety, but the imbalance is unfortunate, if inevitable, since the U.S. proposal on "sidelobe suppression" included in the compromise agreement involves modifications to, or replacement of, the great majority of the transponders now in use. This is because, apart from a few developed very recently in anticipation of the compromise, all existing transponders either (a) meet only the ICAO sidelobe suppression requirement or (b) are of earlier design and without any sidelobe suppression facility. To make category (a) work also with the U.S. type of sidelobe suppression system, and to make category (b) transponders work with both systems, additional circuits are required involving, in some makes of transponder, substantial redesign.

The money spent on equipment now rendered obsolete is however lost, except insofar as real benefit is derived during the equipment's useful life. It is therefore reasonable to expect the airlines to order with caution and not exceed the number of transponders strictly demanded by mandatory ATC requirements, until it is certain that such equipment will not suddenly become obsolete; on the other hand the resultant slowing down of the implementation programme would be most regrettable. The ATCRBS is useful even when only a few aircraft carry transponders, but maximum benefit can be derived only if all aircraft do so. It is therefore urgently necessary to stabilise the system and convince the aircraft operators of its stability, so that they see an extensive installation programme as economically justifiable.

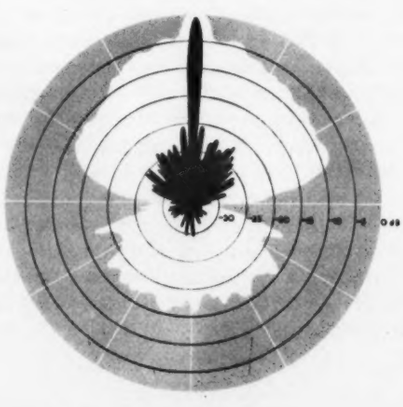
Unfortunately, the ATCRBS is a system of a kind which lends itself to almost unending elaboration and, although equipment manufacture is only just catching up with international agreement, the incorporation of further facilities—involving the provision of an additional airborne box—is actively being discussed. This therefore seems a good moment to take a long hard look at the system and enquire whether these admittedly desirable additional features are really justified.

The recognition codes necessary on both ground-air and air-ground links also allow the system to be used as an air-ground data link, and most of the proposals for system elaboration relate to this aspect. The system at present offers two ground-air "modes" with 64 air-ground "codes" for each (Mode A of the Civil system is identical with Mode 3 of the military IFF Mk.10 system). The interrogation mode to which a transponder will reply and the reply code are selected manually by the pilot, who controls a special identification signal which he can, on request, associate with his transponder's reply.

In this relatively simple form the system provides the ground controller with a clutter-free range and bearing display of all transponder-equipped aircraft within a radius of about 200 miles radio line of sight, and affords positive identification of aircraft without the need to request special manoeuvres. It also reduces the cockpit workload by reducing the need for routine position reporting.

What the present system does *not* offer to the controller is any indication of the height of the aircraft, and considerable thought is being given to this problem. One school of thought (in the U.K.) considers that the problem can be solved with the present 64 air-ground codes. The other (in the USA) deems a much larger number of codes (and hence a system modification) essential. The view is also strongly held in the USA that an "automatic selective reply" (ASR) technique should be used to elicit the height information, i.e. the allocation of a third interrogation mode, the use of which causes the transponder to send a coded response, giving altitude information irrespective of the setting of the pilot's controls. By interrogation sequentially on different modes ("mode interlaces"), the ground equipment can, during one period of illumination, obtain altitude information on one mode and procedural or identity information on others.

Horizontal polar diagram of the Cossor S.S.R.4G secondary radar. The interrogation pattern (black) is very sharply beamed, the control pattern (white) is for sidelobe suppression. The S.S.R.4G ground installation and the Cossor transponder can be easily modified to operate on the FAA three-pulse principle.



Additional reply codes, automatic selective reply and the link between the aircraft altimeter and the transponder can be provided only by additional airborne equipment. To use the extra information thus obtained there is also need for additional equipment on the ground; indeed the full value of the fine-grain altitude information which would result from the adoption of the most extreme proposals could be obtained only by a highly sophisticated ATC system—which is in fact the proposal. It is however pertinent to enquire to what extent one may expect such elaborate control systems to be deployed within, say, the next five years. If the answer is, as it may well be, that only a few centres will be so equipped in that time, it may be more reasonable to stabilise the ATCRBS at some point short of the most elaborate system development so far proposed than to accept the delay in widespread implementation that is likely to result from a policy of continuing development.

More generally, it appears that civil aviation authorities ought, in consultation with airlines, to be attempting to answer the following questions:

1. Is altitude telemetry an essential part of the ATCRBS? Are there other data links (such as AGACS) in development which will provide adequate information? If so, is it impossible to use existing techniques during the interval?

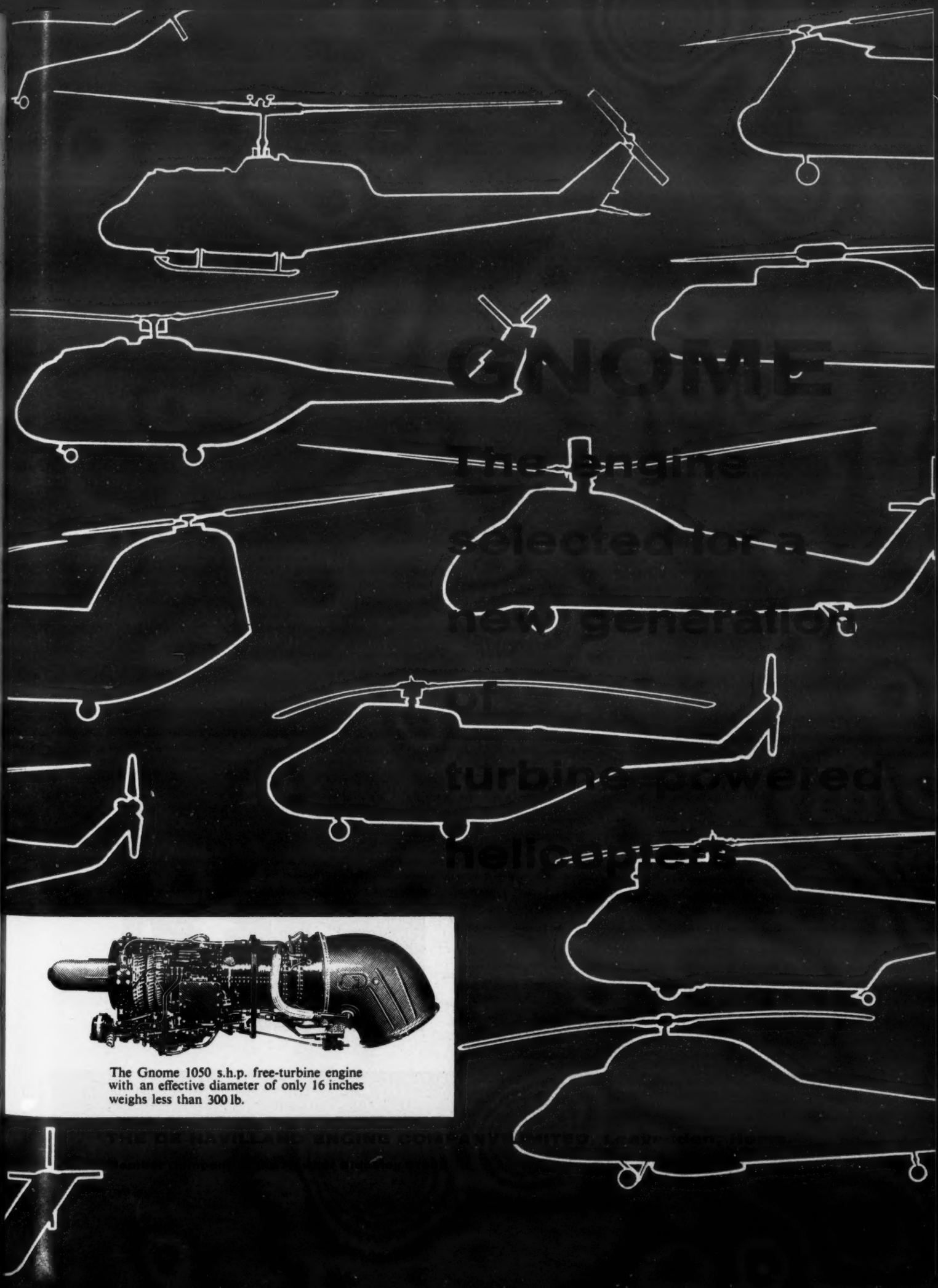
2. If altitude telemetry is essential, what is the minimum operating height above which aircraft must carry the data link? What must aircraft operating wholly below this level carry, if anything?

3. Above the minimum level, must the data link be coupled directly to the altimeter, or can a less sophisticated manual setting procedure be employed?

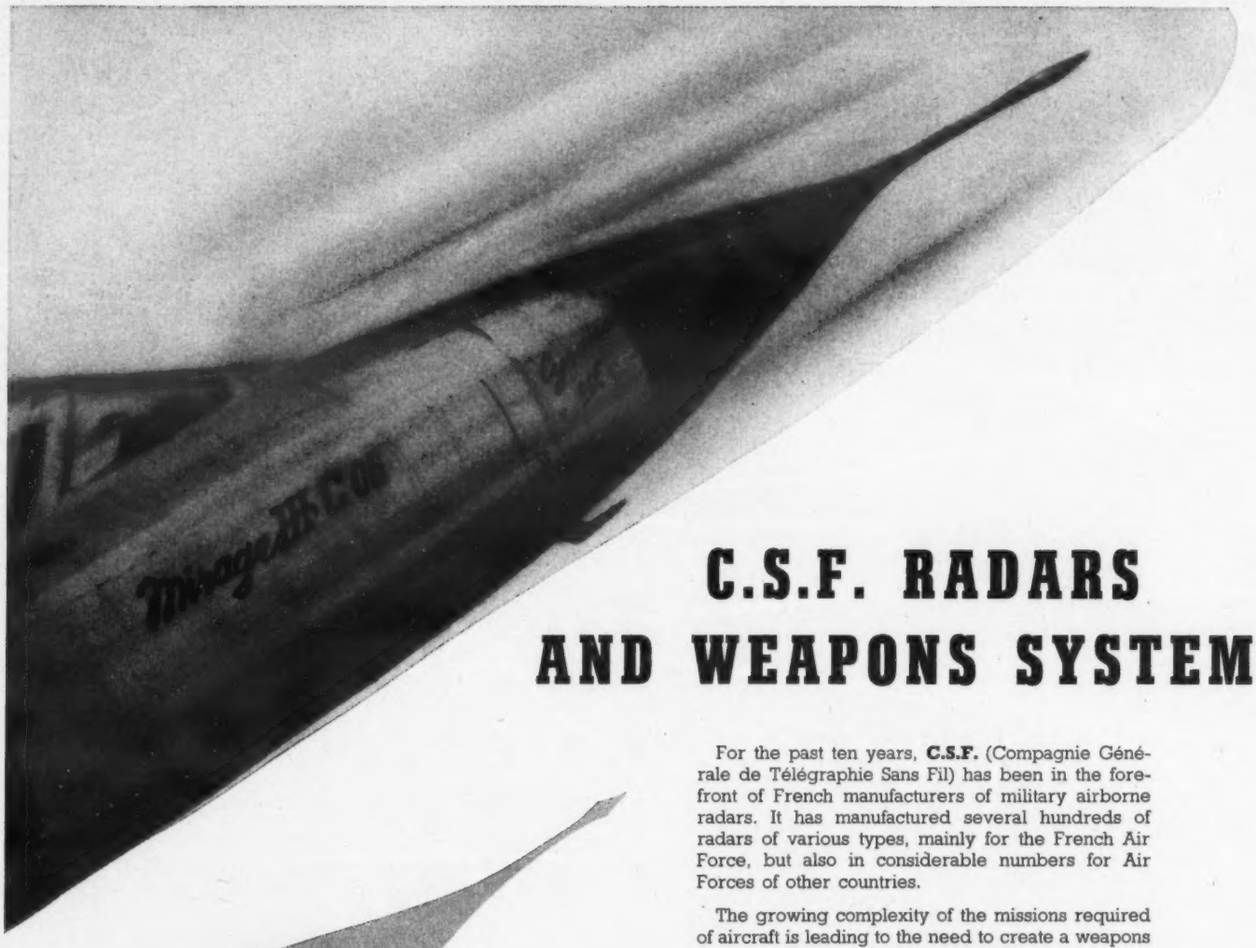
4. If direct coupling to the altimeter is essential, must an ASR technique of interrogation be used, or can the pilot simply switch to data-link operation when so requested by ATC? Is it essential to be able to obtain both altitude and other information during a single illumination period?

5. Can the present 64-code arrangement provide information of sufficient accuracy for control purposes for a reasonable length of time, or is a change to a larger number of codes essential?

The answers to these questions will affect aircraft which fly internationally, and must therefore be internationally agreed. The sooner such agreement is reached—and in this case it would appear to be strictly a matter for ICAO, although doubtless IATA will wish to contribute to the discussion—the sooner will the contribution which the ATCRBS can make to safe and economical flying be realised. ←



The Gnome 1050 s.h.p. free-turbine engine with an effective diameter of only 16 inches weighs less than 300 lb.



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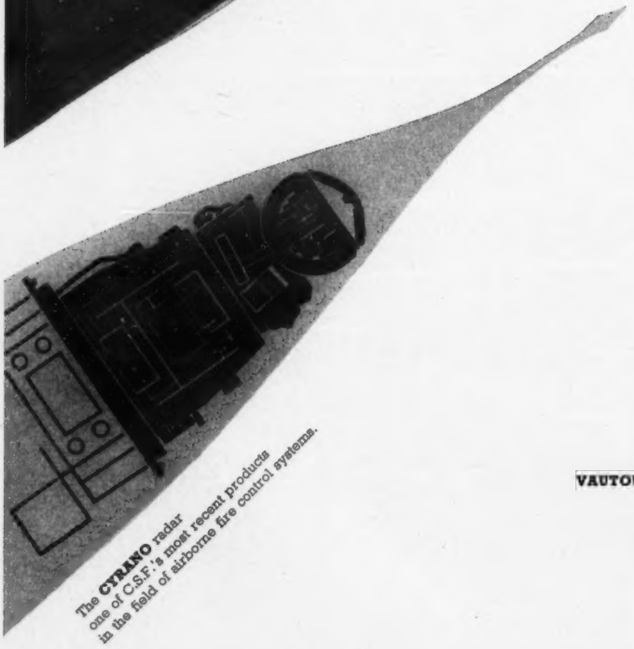
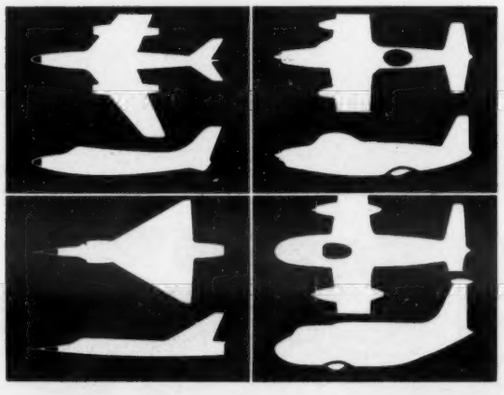
For the past ten years, **C.S.F.** (Compagnie Générale de Télégraphie Sans Fil) has been in the forefront of French manufacturers of military airborne radars. It has manufactured several hundreds of radars of various types, mainly for the French Air Force, but also in considerable numbers for Air Forces of other countries.

The growing complexity of the missions required of aircraft is leading to the need to create a weapons system of which radar is an integral part.

C.S.F.'s research and production departments, which have already developed such equipment, have acquired the experience necessary to solve all the problems posed by the design and manufacture of aircraft and missile radars and their integration into weapon systems.



The **CYRANO** radar one of C.S.F.'s most recent products in the field of airborne fire control systems.



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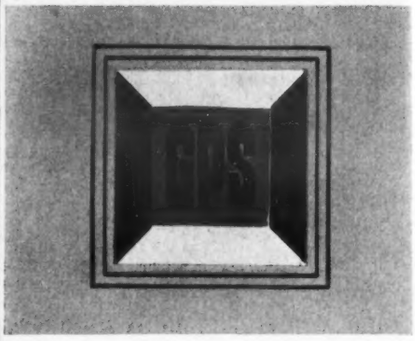
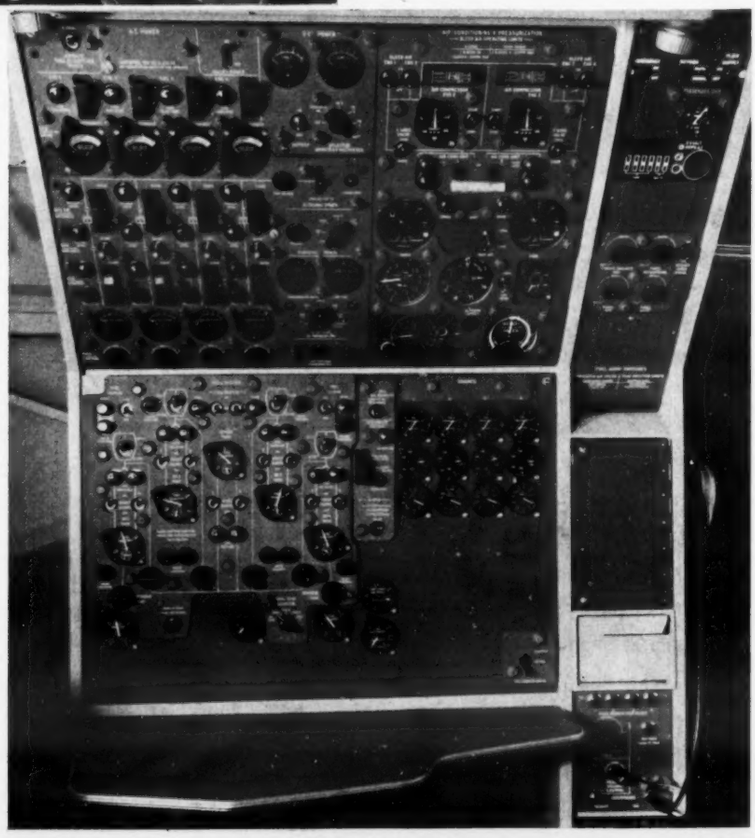


Flight Deck of the G.P.S. BOEING 720-048 Simulator as supplied to AER LINGUS.

Close up view of the Engineers Station G.P.S. BOEING 720-048 Flight Simulator.



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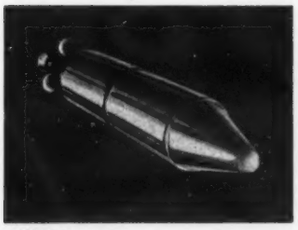
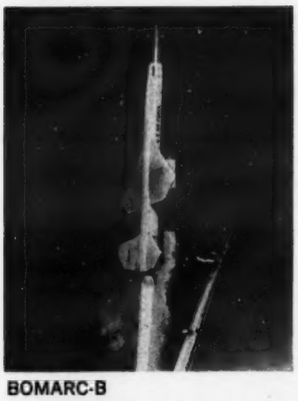


MIDAS



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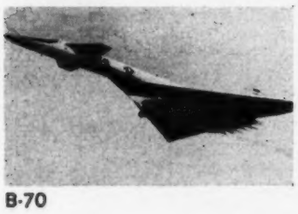

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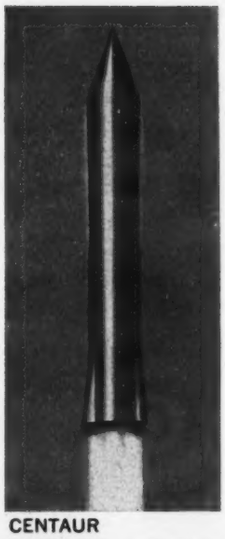

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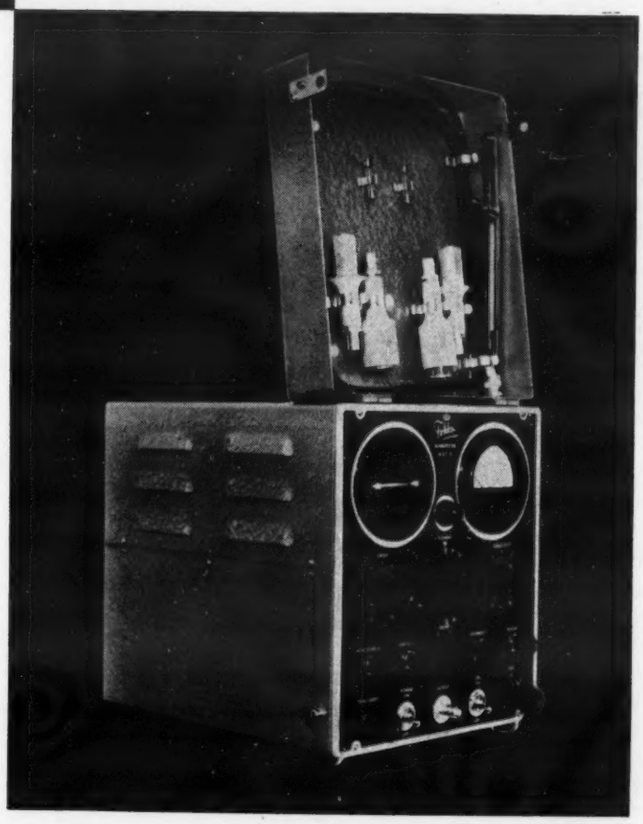

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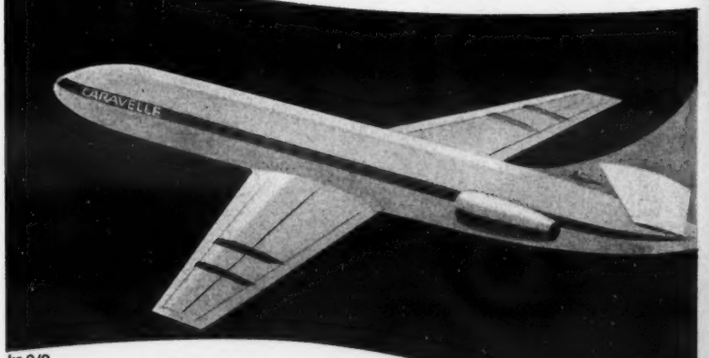

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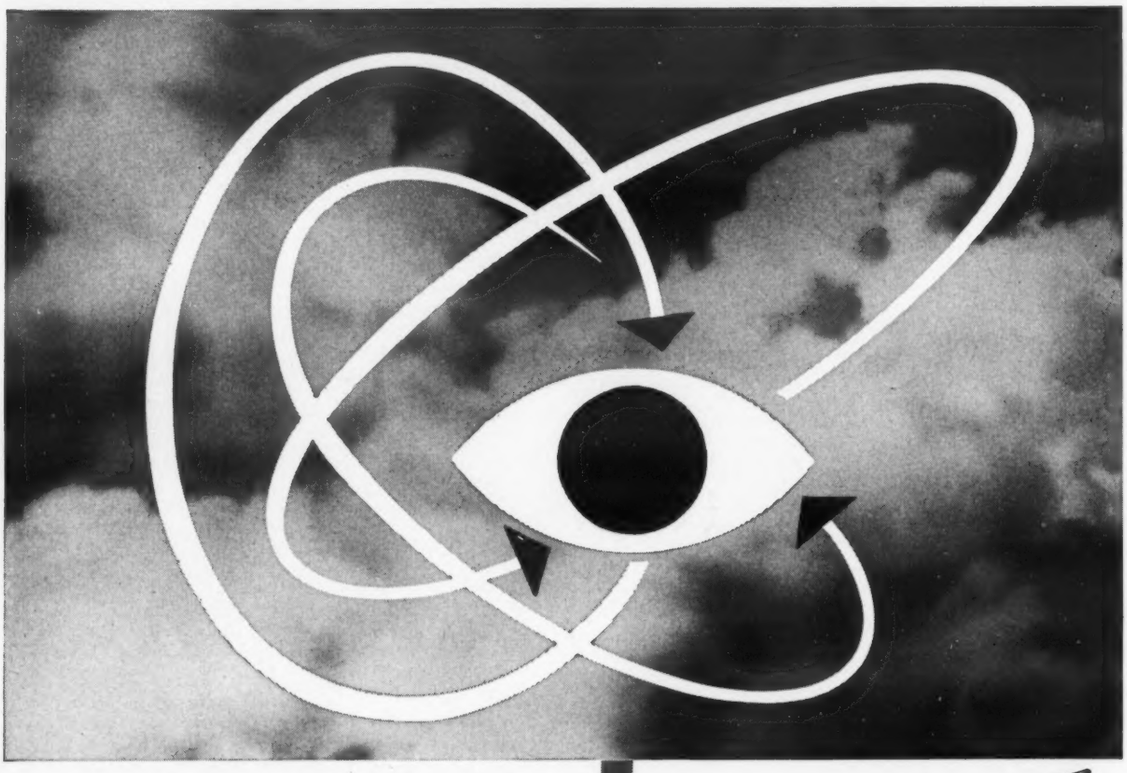

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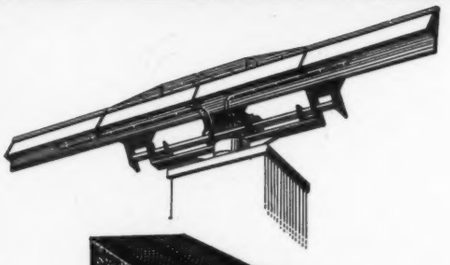

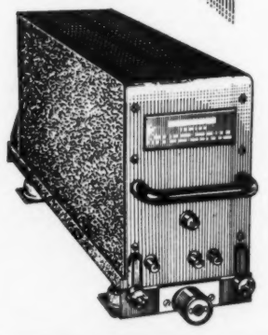

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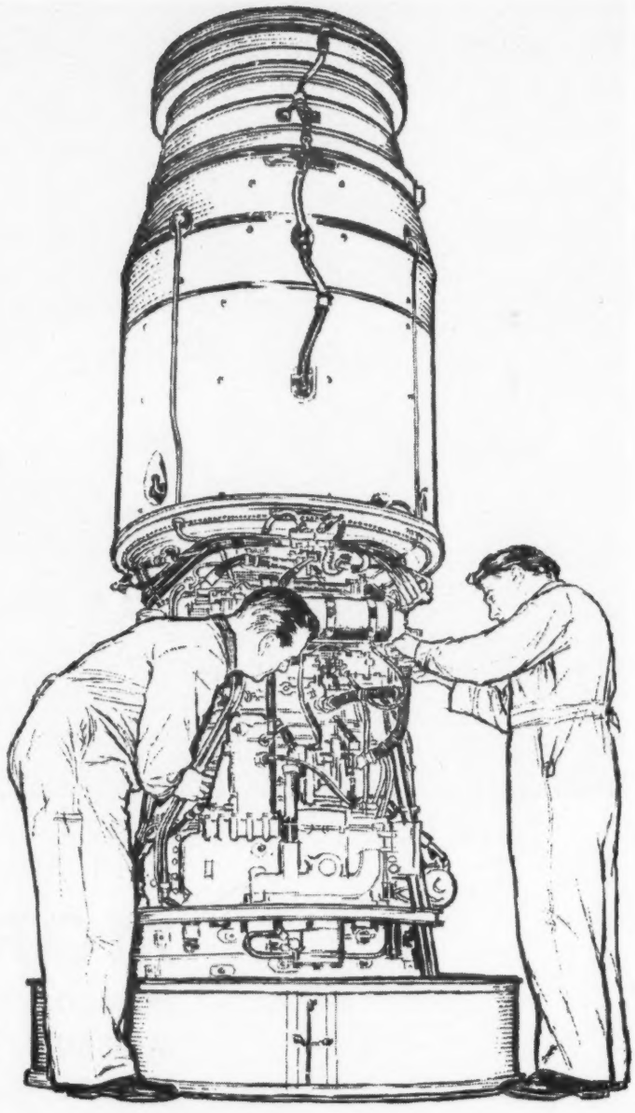

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Avro Vulcan Mk 2 V-bomber

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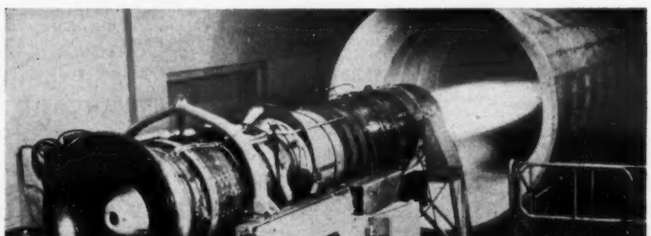
The truly astonishing built-in potential of the Olympus has been confirmed by the threefold increase in power from the 11,000-lb thrust dry of the original production engine, to the 33,000-lb thrust with reheat of the latest version.

SUITABILITY FOR SUPERSONIC AIRLINERS

Already selected for the RAF's most up to date supersonic aircraft, the Olympus will clearly require only minor changes to adapt it to the requirements of a supersonic airliner in the same speed category.



Olympus under test with reheat in operation

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A New Approach to Reliability in Aircraft Radio

By B. Infield, Marconi's Wireless Telegraph Co. Ltd., Chelmsford

In the past twenty years aircraft have changed out of all recognition, and aircraft radio with them. What was, in the early days, a relatively simple matter of communication, with possibly the very simplest form of navigational aid, has now become a complex system closely integrated with the aircraft control system. A modern transport aircraft may have as many as five communication systems and seven or eight radio navigation systems, involved in every phase of its operations from take-off to landing. The consequent size of the radio installation has necessitated its being remotely controlled, again increasing the complexity of the equipment. All this has meant that the radio installation has had a significant impact on available payload, and there has been constant pressure over the years on the radio engineer to reduce the size and weight of the equipment. As an example, a 10 channel VHF transmitter-receiver with a power output of 4 watts, designed in the 1940s, weighed 25 lb, a 140 channel set with an output of 15 watts designed in 1950 weighed 35 lb, while a modern 360 channel set with an output of 25 watts weighs only 24 lb. This is a remarkable technical achievement, but is clearly not the way to achieve optimum reliability. It is a tribute to the design engineers and component manufacturers that modern equipment is no less reliable than the equipment of twenty years ago, but it is equally true that reliability has not improved in the same way as the other aspects of performance.

By and large, aircraft operators have demanded the smallest and lightest equipment possible and have been willing to accept a fairly high failure rate. (High, that is to say, compared to the mechanical elements of the aircraft). As long as a new range of equipment was no less reliable than its predecessors, they did not consider that there was cause for complaint. This attitude is now changing rapidly. As aircraft become larger, faster and more expensive, it becomes increasingly important to achieve a high utilisation, and the economic penalties for delays become correspondingly greater; equipment failures become a costly business. Equally important is the growing use of radio navigational aids coupled to the aircraft control system. For many years radio aids have been used to direct the auto-pilot in en route flying, but now automatic approach and landing systems are being developed, where the radio aids are directing the aircraft right down to the runway. In such systems equipment reliability is clearly of primary importance, since the whole safety of the aircraft depends on it.

The point has now been reached when it has become more important to improve reliability than to decrease size and weight. Aircraft radio equipment has already been miniaturised to the extent that the law of diminishing returns has a significant effect. Not only is the weight of the radio installation a much smaller proportion of the gross weight than in earlier aircraft, but the fixed fittings, such as the aerials, cables and mounting racks, the weight of which remains substantially constant, already account for about 60 percent of the total weight of the radio installation. Even if the weight of the individual radio units were halved, the overall effect would be relatively small.

The present concern with reliability has come at a most appropriate time for the radio engineer, as it coincides with the general availability of transistors for a wide range of applications. Prior to the introduction of transistors, the electronic designer was always limited in the ultimate reliability of his equipment by the reliability of the thermionic valve when used in an aircraft environment. The transistor, however, does not suffer from the same limitations as the valve. It is not, first of all, an essentially limited life device. It is free from microphonic effects and, due to its small size and rigidity of construction, can withstand the vibration encountered in aircraft.

There were, initially, a number of problems in the application of transistors to airborne equipment, mainly concerned with ambient temperature limits and power supply surges. Recent developments, however, have greatly extended both the temperature and voltage ranges of transistors, and circuits have been evolved to give protection against supply transients. In a research programme conducted by Marconi's Wireless Telegraph Company, circuits of all types were tested under temperature-cycled conditions and accumulated more than 30,000 hours of continuous operation. It became clear that not only did the advent of transistors enable the designer to make much smaller and lighter equipment, but that a major improvement in reliability was also possible. But in order to exploit these possibilities to the full it was necessary to take a fresh look at the whole problem of reliability.

Due to the circumstances in which aircraft radio is operated, it is difficult to obtain sufficient information on the causes of equipment failure for a statistical survey. But clear patterns do nonetheless emerge when failures are analysed and grouped according to the fundamental cause of breakdown.

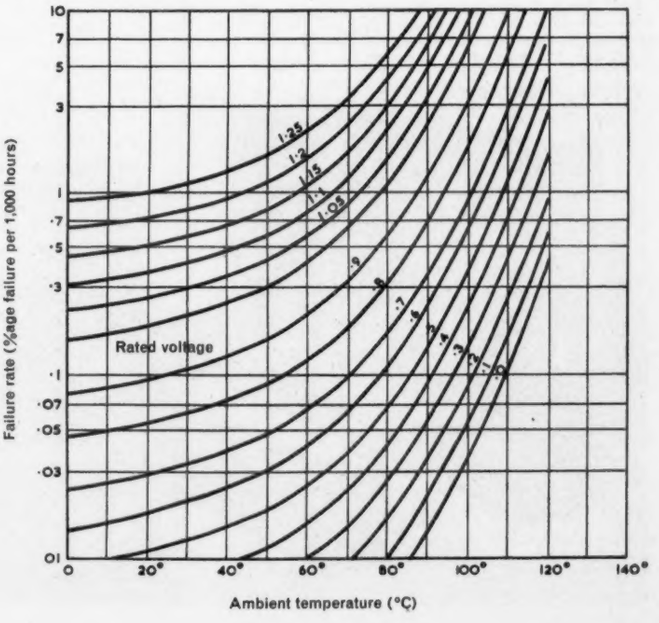
Fig. 2 shows an analysis of failures into five major classifications—those due to environment, components, manufacture, design and maintenance. A study of this chart shows the extent to which transistors can contribute towards reducing equipment failures.

Of the environmental causes of failure, heat is easily the most serious. The importance of saving space in modern aircraft, which has led to progressive miniaturisation of the radio units, has also led to the units being packed tightly together in a radio rack. Thus not only is the component density of the individual units high, but the ratio of surface area to volume of the radio rack considered as a whole is relatively low. This has resulted in a serious heat dissipation problem. Expedients such as forced air cooling help, though they certainly do not remedy the situation. Transistorisation, on the other hand, reduces the watts dissipated to a tenth or less. Operating temperatures of the units are much lower and cooling of the equipment is no longer a problem.

The reliability of valve equipment is essentially limited by the finite life of the valve itself. Transistors have no finite life, in this sense; there is a slow deterioration in performance, which is not important if the circuits in which they are used are sufficiently tolerant, but even this deterioration is a function of the manufacturing processes, and almost unlimited improvement is possible. Generally speaking, the life of a transistor will be longer than that of the aircraft. Quite as important as the inherent reliability of the transistor itself is the fact that it is a low voltage device. Thus most of the components in a transistorized equipment will be working far below their rated values at stabilized voltages of 7 V or 14 V, with a few at 28 V. This results in a very marked improvement in component reliability. *Fig. 1* shows a typical family of failure rate curves for a capacitor, which indicates clearly the gains to be derived from reducing operating voltages and temperatures. Curves for resistors and inductances are similar.

In the basic design of circuits much can be done by applying systematic reliability engineering techniques, in which each circuit is checked at extremes of component tolerances under all environmental conditions, with additional factors added for component aging. The same techniques can be applied to mechanical design by checking mechanisms at extremes of mechanical tolerances, with artificially induced wear. Much work has also been done recently on the application of new materials to mechanisms, and

Fig. 1
The set of curves represents a typical example of the changes in the failure rate of a silvered mica capacitor at different ambient temperatures and operating voltages (with respect to the rated voltage). Similar sets of curves apply to resistances and coils.



it is now possible to design dry bearings which require no lubrication during the life of the equipment.

The effect of heat on equipment reliability has already been discussed. But there still remain the environmental hazards of vibration, pressure, humidity and contamination. These are all very important in aircraft equipment. Here again transistors open the door to the solution. Due to the low heat generated in transistorised equipment, circuits can be enclosed in hermetically sealed modules filled with a dry inert gas. This eliminates, at one stroke, all effects of pressure, humidity, and contamination, and the rigid construction and small dimensions of the units minimises the effects of vibration.

This type of construction is used by Marconi's Wireless Telegraph Company in its new range of transistorised aircraft equipment. Two sizes of module are used, the standard one being $2'' \times 2'' \times 6\frac{3}{4}''$. A typical module is shown in *Fig. 3*. The components are mounted on a chassis attached to the base, and the external connections are taken out through the base. The cover is fixed to the base and sealed with a rubber gasket, but can be easily removed by undoing four screws. The modules are mounted on a hollow, insulated channel on the bottom of the equipment, which carries the interconnecting wiring. Connection to the modules is by screw contacts, eliminating miniature plugs and sockets which are an endless source of trouble.

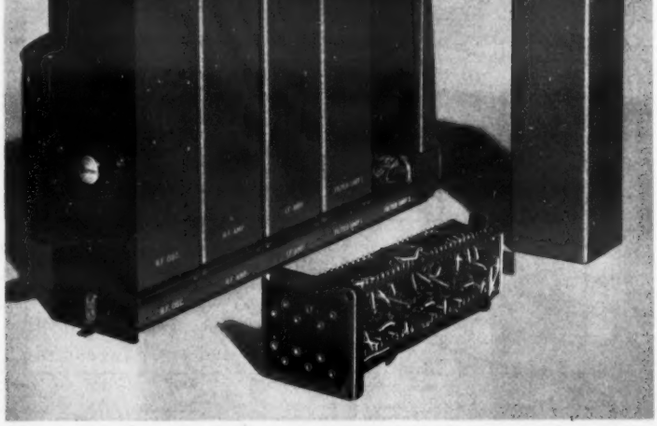
Modular construction also helps in manufacture. The containers can be mass-produced, and the internal chassis can be designed to use many common parts. Furthermore, the modules can be inspected and tested independently. In highly miniaturised equipment the problems of inspection and test become increasingly severe, and the ability to break the equipment down into manageable self-contained units makes these functions very much easier.

Maintenance problems are also considerably simplified by the use of sealed modules. Each module can be fully tested without unsealing, and routine maintenance can be carried out in a highly standardised form, with no danger of accidentally damaging or disturbing the circuits being tested. In the event of there being a fault, it can be quickly traced to the module concerned, and only in such a case would a module be opened. It can be then repaired, resealed and filled with dry nitrogen; no special equipment is needed for this. A sealed module has almost all the virtues of encapsulated circuits but can be repaired instead of being thrown away if a fault develops.

Having greatly reduced what are at present the major causes of equipment failure, the minor ones, such as random component failures, become more prominent. It is thus necessary to establish more rigorous methods of component selection and test, and general quality control in manufacture becomes even more important than hitherto.

It is certain that these new techniques of design and construction will very greatly improve the reliability of aircraft radio. The exact measure of this improvement will not be known until the equipment has been in service for a year or so, but it can be safely predicted that it will make a valuable contribution to aircraft safety, reliability and economy. ←←

Fig. 3:
Modular construction of a Marconi miniaturized Type 6404 glide path receiver. The separate modules are hermetically sealed and filled with dry nitrogen. The fact that the modules can be tested individually greatly simplifies maintenance and fault-finding. After repair, the module can be reassembled, filled with nitrogen and used again.



Classification of faults *(Fig. 2)*

Environment		
Heat	*Valves*	Cathode deterioration Secondary emission Interelectrode leakage Imperfect pin contact
	Relays	Coil failures
	Capacitors	Change of value Short circuits
	Resistors	Change of value Open circuits
	Inductors	Change of value Open circuits Short circuits
	Mechanisms	Deterioration of lubricant
Vibration	*Valves*	Microphony Short circuits
	Relays	Contact bounce Arcing Noise
	Capacitors *Resistors* *Inductors*	Change of value Broken end connections Open circuits
	Plugs and Sockets	Open circuits Noise
	Switches	Intermittent connections
	Wiring	Open circuits Short circuits
Pressure / Humidity	*Valves*	Less cooling at altitude Pin corrosion
	Relays	Coil and contact failure due to corrosion
	Capacitors	Leakage & eventual short circuit
	Resistors	Change of value
	Inductors	Change of value Open circuits due to corrosion
	Plugs and sockets	Pin corrosion Insulation leakage
	Metals	Corrosion
	Bearings	Loss of lubricant
Contamination	*Switches, Relays* *Plugs and sockets*	Open circuits Noise
	Insulators	Leakage
Components		
Finite life	*Valves*	1000—10,000 hrs.
	Capacitors *Resistors*	Life depends on rating and circuit conditions
Early failures	*Valves* *All Components*	Undetected manufacturing flaws
Manufacturing	*Soldering*	Dry joints Loose solder Insulation damage
	Adjustments	Incorrect mechanical adjustments
	Finishes	Incorrect surface finishes
	Components	Outside specified tolerances
Design		
Mechanical	*Wear*	Design is intolerant of wear
	Lubrication	Fails due to environment
	Adjustments	Too critical
	Gears	Fail due to lubrication failing
	Springs	Material variations
Electrical	*Circuit*	Critical of component values
	Adjustments	Difficult to adjust with adequate safety margins
	Components	Local heating causes overloading
Maintenance		
Mechanical	*Soldering*	Dry joints Damaged insulation Loose solder
	Adjustments	Incorrect adjustments
	Lubrication	Use of incorrect lubricants
	Damage	Unnoticed damage to other components during inspection or repair
	Storage	Corrosion due to storage environment
Electrical	*Adjustments*	Incorrect adjustment Accidental disturbance of present adjustments and wiring
	Overloading	Accidental overloads weaken components

Sending Data Back From Space

The Ampex FR-100B Recorder-Reproducer

The objective of the U.S. National Aeronautics and Space Administration's Project *Mercury* is to place a manned space vehicle into an orbit 100 miles above the earth. After several orbits, lasting approximately 90 minutes each, the capsule is to return safely to earth, coming down somewhere in the Atlantic. Although the entire flight of the space vehicle will last only a few hours, there will still be plenty of time to gather a wealth of scientific information of all kinds.

It must therefore be possible to display telemetered data in real time at various observation stations, at the same time recording them on magnetic tape. In addition to the reliable operation of booster and space vehicle, the smooth transmission and recording of all data measured during the flight is of major importance. Equipment for the reception, presentation and recording of all the information transmitted from space is at hand at fourteen of the widely dispersed observation stations. A fifteenth recording equipment will be installed at the NASA station at Wallops Island, off the Virginia coast. Other stations are equipped with receivers, but have no recording equipment, as they pass the information received directly to the main observation stations.

As prime contractor, Western Electric is responsible to the National Aeronautics and Space Administration for project management training and ground-to-ground communications. Bell Telephone Laboratories is responsible for engineering and design consultation and control centre display systems. International Business Machines Corporation supplies the computers and is responsible for their programming, while the Burns & Roe architect-engineering firm carried out the building work on the stations (now complete) and is responsible for logistic support. Finally, the Bendix Corporation supplies the telemetry receiving, display and radar data transmission equipment (Pacific Division), radar tracking and ground-to-spacecraft voice, acquisition and command systems (Radio Division).

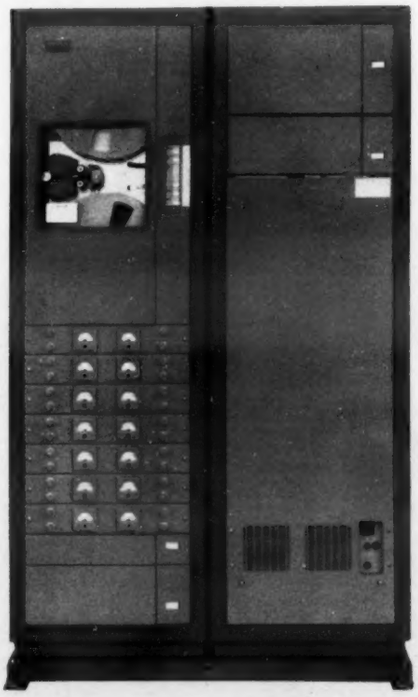
Installation of the electronic equipment is proceeding according to plan, and Bendix Corporation is installing an Ampex FR-100B recorder-reproducer in each of the fourteen main stations and at Wallops Island. For the initial unmanned *Mercury* flights, the magnetic tape systems will record spacecraft environmental and performance data only. Later, during manned orbital flights, the tape units will collect data on man's physiological and psychological reactions while in orbit.

Important as the first unmanned spacecraft tests will be in the gradual buildup of space experience, the ultimate goal—that of placing a man into an earth orbit and bringing him safely back—is imposing new and unprecedented reliability requirements on the magnetic tape units and on all the electronic and communications equipment. For it is imperative that the world-wide tracking network be capable of operating continuously throughout the course of each *Mercury* flight.

To ensure the safety of the spacecraft and its occupant, only systems and components of proven reliability are being used to instrument the sites. To perform the exacting recording task, an Ampex FR-100B recording system was selected, as it is the direct successor to the FR-100 and FR-100A, both of which are well known and have long records of reliability in the data processing field.

Only one type of magnetic tape system is being used by Bendix-Pacific throughout the network. This provides a partial solution to the major problem of transmitting information between facilities. It also simplifies the problem of input and output impedances, frequencies and voltage levels, which must be compatible throughout the communication system.

The Ampex FR-100 B magnetic tape recorder-reproducer.



The FR-100 is manufactured in several configurations and can be used for direct, frequency-modulated (FM), pulse-duration modulated (PDM) or digital (NRZ) recording. It can use either ½ inch or one inch wide tape on either 10½ inch or 14 inch diameter reels. Depending on the mode of recording selected, it will record up to 32 tracks of digital information, or place a combination of 16 digital and 7 analogue tracks of information on one inch wide tape.

The particular configuration that will be recording the astronaut's reactions uses 3,800 ft of one inch wide tape on reels of 14 inches in diameter. Fourteen tracks are sufficient to record the information supplied by a total of 91 data channels, receiver strength in ground/air communications and Greenwich Mean Time.

Ampex specifically designed the FR-100B for applications where maximum signal accuracy and superior flutter characteristics are essential. A closed-loop tape path on a rigid cast aluminium tape transport frame gives the unit structural stability—considered to be a fundamental item in low-flutter design. All major assemblies are mounted on this rigid transport. It not only contains the components necessary for moving tape over the magnetic head assembly, but also provides central tape control.

Two other features of the FR-100B prompted its selection for the telemetering network, according to a Bendix-Pacific spokesman. First, a system with front accessibility of all components was required, so that as little time as possible is wasted in maintenance and regulation. Because the tape transport mechanism on the FR-100B is hinge-mounted, it can be swung out towards the operator for access to the assemblies mounted on the rear of the aluminium casting. Secondly, the electronic design offered a number of advantages. The use of an individual bias oscillator for every track of information ensures that if one oscillator should fail, the other tracks will still be operative. Most recording systems today do not have this feature.

In addition, both the record and reproduce amplifiers are sturdily built, with all fixed-circuit elements attached to etched epoxy-glass circuit boards. Doubtful performance on any track can be corrected immediately by module replacement, and the replaced unit can be bench-checked as time permits. In the Project *Mercury* network, spare power supplies and spare amplifiers of all types will provide a standby for every electronic component. ←←

Multi-Purpose Trainer and

Business Aircraft

North American Sabreliner

In March, 1956, after a thorough investigation of the market, North American Aviation Inc. decided to develop a twin-jet multi-purpose aircraft with an all-up weight of 17,760 lb, which would cover ranges of up to 1,920 miles at speeds of some 500 m.p.h. and altitudes of above 40,000 ft. Although the USAF had shown interest in a training and communications aircraft of this weight and performance class, the company designed and built the prototype of the low-wing aircraft, designated *Sabreliner*, as a private venture. In drawing up the project, however, account was taken of the Air Force's UTX Specifications for a twin-jet combat readiness trainer and the UCX Specifications for a multi-purpose transport aircraft.

In designing the *Sabreliner*, North American is quite rightly bearing in mind its possible civil applications. As the market analyses showed, the wishes of practically all those interested in business aircraft can be met by a fast, six- to eight-seat, easily maintainable model—though sales to the civil market will remain limited to aircraft owners in countries where high speeds and long ranges are major requirements. Moreover, the purchase price of a fully equipped *Sabreliner* (about $900,000 with spares) will restrict its use to larger industrial concerns. Since, however, USAF orders so far total no less than 94 aircraft of the T-39A, B and C military versions and production has already begun at North American's Los Angeles works, civil orders should not be long in coming.

*

The story of the *Sabreliner's* development is characterized by an exceptionally tight schedule. In November 1957 the first drawings were sent to the workshops, and by May, 1958 the prototype was completed ahead of schedule. On September 16th of the same year the first flight, lasting 55 minutes, was made. While the USAF test programme at Edwards Air Force Base was still under way, an Air Force order for seven T-39s was received, followed by a further order for 35 aircraft. The first production aircraft was rolled out in May, 1960, and a few months later the USAF ordered yet another 52 *Sabreliners*.

The T-39, which follows on from the well-known North American F-86 *Sabre* and F-100 *Super Sabre*, has a swept wing with automatically actuated leading-edge slats; the horizontal tailplane, also swept, has separate, manually actuated control surfaces, but the whole unit can be moved over a wide angle by an electric motor.

The two Pratt & Whitney JT12-6 jet engines at each side of the fuselage (3,000 lb thrust) lie so near the longitudinal axis of the aircraft that asymmetrical thrust in single-engine flight can easily be trimmed out. The normal fuel supply of 899 U.S. gal. is carried in the wings, which consist of two integrally stiffened sections. Directly behind the cabin, taking up the entire width of the fuselage, is another fuel tank with a capacity of 163 gallons.

Large windows above and at the sides of the wide-angle windscreen give excellent visibility upwards and obliquely downwards. Icing and misting of the windscreen are prevented by electric heating. The instrument panel is so designed that all instruments are visible from either of the side-by-side cockpit seats. Check lists for take-off and landing, cabin light switches and anti-icing controls, and electrical and radio master switches are on a small overhead panel on the central window frame. Throttles and engine controls are mounted on a pedestal between the pilots' seats. On the left side of the fuselage, between the cockpit and the passenger cabin, is the door, with built-in staircase. The fuselage rear contains the air-conditioning and pressurization system, batteries and hydraulic actuator

The first operational T-39B trainer, equipped with NASARR and doppler navigation system, being handed over to the USAF on February 15th, 1961.

systems for undercarriage, air brakes and wheel brakes. The air conditioning system is fed via a heat exchanger from an air inlet at the root of the fin.

Cabin pressure is barometrically regulated to an altitude of 8,000 ft, even at the highest altitudes. Oxygen masks, whose valves open automatically, are stowed in the roof for use by passengers and pilots in the event of a sudden pressure loss.

*

The economical operation of a jet aircraft, both for civil and for military applications, depends to a considerable extent on keeping maintenance and ground handling to a minimum. The number of ground vehicles and personnel required should be kept as low as possible. North American has met this requirement by incorporating a number of special design features. Pressure refuelling can be carried out at a single point under the starboard wing, while passengers and freight are disembarked on the port side. Most of the systems and pieces of equipment can be checked without the need for maintenance platforms. The installation of the two JT12 engines in nacelles at the fuselage rear facilitates their inspection and overhaul. The robust, entirely mechanical control system requires a minimum of maintenance. Normal pressure and hydraulic test equipment, oxygen filling equipment etc. can be used throughout. The T-39's electrical system supplies enough energy to start the jets without assistance from the ground.

Technical data for the North American T-39

Powerplant

2 Pratt & Whitney JT12-6 turbojets
Static thrust . . . . . 3,000 lb

Weights

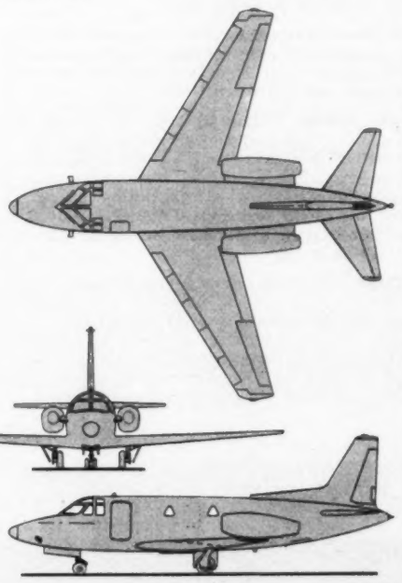
Airframe empty weight	8,152 lb
Operating empty weight	9,960 lb
Take-off weight	17,760 lb
Fuel capacity	1,056 U.S. gal.
Useful load (normal)	7,800 lb

Dimensions

Span	44.4 ft
Overall length	44 ft
Overall height (to tip of fin)	16 ft
Wing area	342.1 sq.ft.
Sweep (at quarter chord)	28.5°
Track width	7.20 ft

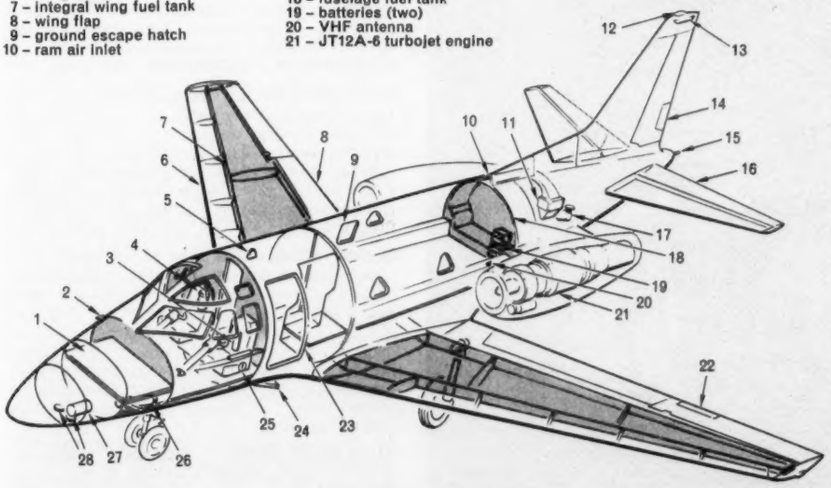
Performance

Take-off roll at sea level	2,500 ft
Landing roll at sea level	1,850 ft
Maximum speed	520 m.p.h.
Cruising speed	500 m.p.h.
Landing speed	105 m.p.h.
Cruise altitude	above 40,000 ft
Single-engine ceiling	20,000 ft
Range (with normal reserves)	1,800—1,900 miles



Sectioned drawing of the *Sabreliner*

1 – space for equipment
2 – pitot head
3 – hand fire extinguisher
4 – portable oxygen bottle
5 – VHF antenna
6 – wing slats
7 – integral wing fuel tank
8 – wing flap
9 – ground escape hatch
10 – ram air inlet
11 – heat exchanger
12 – anti-collision light
13 – VOR localizer antenna
14 – rudder trim tab
15 – fuel jettison and vent
16 – trimmable horizontal stabilizer
17 – hydraulic reservoir
18 – fuselage fuel tank
19 – batteries (two)
20 – VHF antenna
21 – JT12A-6 turbojet engine
22 – aileron trim tab
23 – entrance door
24 – speed brake
25 – wing ice check light
26 – oxygen bottle
27 – 2,500 VA inverter
28 – landing and taxi lights



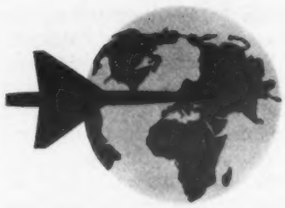
North American began flight testing the *Sabreliner* at its own airfield at Palmdale, California on September 16th, 1958, and several USAF pilots also participated in further tests. Later, the FAA joined in the test flight programme. For the static tests, the manufacturers planned a four-phase programme (now complete). This was as follows: Phase I comprised rigidity tests of the main assemblies, such as wings, empennage, fuselage and undercarriage. In Phase II the main components and equipment parts were tested for rigidity and fatigue, being subjected to stresses equivalent to three times the life of the aircraft. Phase III, a series of hydrostatic tests in the Convair water tank at San Diego, was designed to detect weak points in the structure of the pressure cabin. Finally, in Phase IV, the aircraft systems, including fire extinguisher, fuel feed system and electrical system (antenna positioning etc.) were tested. In addition, a T-39 was subjected to temperatures of between −18 °C and +50 °C for a week at Eglin Air Force Base. In January and February, the same aircraft was subjected to operational trials at Eielson AFB, Alaska. On completion of these tests in late summer this year, the *Sabreliner* will receive FAA certification, after which North American will raise the monthly production rate from one aircraft to five.

*

In addition to the standard T-39A version, which is designed both for civil and for military applications, North American has developed a second version, designated T-39B, under contract to the USAF Tactical Air Command. The six aircraft of this version are to be used as tactical trainers for pilots who will later fly the Republic F-105D single-seat combat aircraft, and carry a complete NASARR navigation and fire control system plus a doppler radar. Yet another version of the *Sabreliner*, the T-39C, is intended as an ECM aircraft (to jam or decoy enemy radar) and will also serve to train the radar operators of long-range bombers. Like the standard T-39A version, the T-39C is destined for the USAF Air Training Command, with the A version aircraft being used mainly for training and refresher courses for reserve pilots and for combat readiness training. In addition to pilot, co-pilot and/or radar instructor, the B and C versions can carry three pupils, who can be trained on electronic equipment under operational conditions. The A trainer version could carry, in addition to pilot and co-pilot, five or more trainee pilots on a single flight.

Whatever the version used, the North American development team has succeeded in assisting the USAF in its endeavours at rationalization, at the same time creating a competitive business aircraft for the industrial concerns of countries where distances are long.

The fact that North American Aviation is bringing the T-39 *Sabreliner* to Europe for the 24th Paris Air Show is unmistakable evidence of the company's intention to obtain a footing in the European market. Certain NATO States, above all the Federal German Republic, need a rapid multi-purpose aircraft which can carry a payload adequate to permit the training of fighter pilots in modern navigation and fire control techniques. ←



What's in the Air?

AIR TRANSPORTATION

IATA North Atlantic operators were due to meet in Montreal on May 1st in an attempt to resolve their differences and agree new Atlantic freight tariffs. The operators have agreed to maintain current freight tariffs on the Atlantic run until June 30th.

The United-Capital merger should be completed by June 1st, and integrated schedules should be in operation by July 1st on current planning. All Capital flight and ground personnel will be incorporated into the merged cooperation, and no personnel layoffs are contemplated. United expects to operate 30 percent more seat-miles next autumn resulting from the introduction of larger transports on the longer routes, including some 38 new DC-8, *Caravelle* and Boeing 720s to be brought into operation during the next few months.

Northeast Airlines has dropped earlier plans to merge with Trans World Airlines for the present time.

Pacific Northern Airlines, the U.S. carrier operating services to Alaska, has ordered two Boeing 720s for delivery in 1962. In mid-April the Boeing 707/720/727 order-book totalled 366 aircraft.

Western Air Lines is considering a possible order for four or five Boeing 720B jet transports, but a contract depends on CAB awarding a West Coast–Hawaii route. CAB decided in favour of Western last December, but a final decision was held up by President Eisenhower. Western is also considering the possible purchase of two Boeing 707s currently on lease from Boeing.

British Overseas Airways Corporation has arranged to continue airframe-engine insurance cover on its Boeing 707 and *Comet* aircraft through the London insurance market, but the Corporation will carry own risk on *Britannias* and DC-7Cs. Insurance for liability to passengers is still covered through the London market. During the discussions, London underwriters stressed the high cost of Boeing 707 repairs. In two and a half years' service involving half a million flying hours, there have been 23 major flying accidents with Boeing 707s, of which 15 were on landing. Only one incident involved passenger insurance, but a number of others carried repair bills of between £100,000 and £1 million.

Sabena DC-7 freight service to New York will be stepped up from two to three flights a week from May 9th.

The Baghdad Civil Aviation Conference attended by representatives of the Arab States last month approved a £17 million plan to establish a joint international Arab airline operating on overseas routes. Iraq and the United Arab Republic will each subscribe 20 percent of the capital, and Kuwait and Saudi Arabia will each put up 15 percent. Lebanon and the Yemen have agreed in principle to participate. The project requires approval by the Arab Economic Council before the new airline can be established.

The Western European Airport Authorities' 1961 annual conference is scheduled for June 4th–10th in Stuttgart. Delegates to the conference will visit Berlin and Frankfurt/Main Airports.

Saudi Arabian Airlines is believed to have given Boeing Airplane Company a letter of intent for three model 727 transports, with an option on a further three, according to reports reaching Geneva. No confirmation is available from Boeing to date. Last year, the carrier rejected a TWA evaluation team's recommendation to purchase Boeing jet equipment for service in 1965.

Madair will be the title of a new Malagasy national airline to be formed by agreement with Air France and Air Madagascar (a TAI associate). The new carrier is due to commence operations on October 14th (Madagascar's Independence Day) with DC-4, DC-3 and de Havilland *Dragon* aircraft on domestic routes plus a scheduled Tananarive-Brazzaville service.

The first Canadian-built CF-104 for the Royal Canadian Air Force was rolled out at Canadair's Montreal plant on schedule at the end of March. The first three production models are going to Burbank for checking and flight testing by Lockheed Aircraft Corp. The Royal Canadian Air Force is due to take delivery of the first of 200 CF-104s in the autumn of this year.

Malayan Airways Ltd. is now reportedly considering ordering jets and not short-haul turboprops to take over some DC-3 and *Viscount* local operations. Earlier this year, MAL was studying the Avro 748, Fokker F.27 *Friendship* and Handley Page *Dart Herald*. This new move, if confirmed, may indicate a tendency on the part of uncommitted operators with DC-3 and similar aircraft to opt for short-haul jets for delivery from 1964 onwards.

The Austrian Government has approved a three-year technical and commercial cooperation agreement between Austrian Airlines and Pan American World Airways. PanAm will study AUA's technical set-up and commercial organization, advise on increasing the carrier's economic potential, explore possibilities for commercial development. The AUA management stresses that the PAA team will act only in an advisory capacity. AUA has set up a committee to study jet requirements and report back in three months' time.

INDUSTRY

Douglas Aircraft says that the new DC-8F *Jet Trader's* (see picture) operating cost of $3.23 per mile will permit a profitable operation at 46.3 percent break-even point, based upon 54 passengers and 26 tons of cargo on an intercontinental Amsterdam–New York run of 3,100 n.m. Donald Douglas Jr. foresees an initial market of 500 aircraft and says that the DC-8F's nearest competitor is the Boeing 735 version of the 707–320. No orders have yet been booked for the DC-8F, but several carriers have shown interest for possible long-haul intercontinental use, particularly on trans-Pacific runs.

Sperry Rand Corp. has received U.S. Navy contracts totalling $8.5 million for the manufacture and management of navigation systems in ten new *Polaris* submarines. Nine of the vessels will be of the *Lafayette* class, and the tenth of the *Ethan Allen* class.

Computing Devices of Canada Ltd. of Ottawa has signed a licensing agreement giving the West German company *Teldix Luftfahrt-Ausrüstungs GmbH* of Heidelberg (a Telefunken-Bendix subsidiary) production rights on its Position and Homing Indicator equipment. Teldix will produce 1,000 PHIs for the West German Air Force, including PHI-3s for the Fiat G.91 and PHI-4s for the Lockheed F-104G *Starfighter*. CDC has already delivered 66 PHI-4s to Lockheed for installation in F-104s being built in Burbank for West Germany. CDC recently signed a similar agreement with Ottico Meccanica Italiana (OMI) of Rome, covering Italian production of PHI-3s for the Fiat G.91. CDC is well ahead of schedule with PHI-5 production for Canadair CF-104s being built at Montreal for the RCAF. Production rate is 16 equipments per month.

Brantz Mayor has been appointed Regional Director of Boeing Airplane Company's International Operations Office in Paris. Mayor is at Seattle for a two-month indoctrination before moving to Paris in June.

Marconi's Wireless Telegraph Company Ltd. has signed an agreement with Wilcox Electric Company Inc. of Kansas City for full interchange of design, engineering and production information on radio and radar equipment. The agreement covers manufacture and sale by either company of equipment designed by the other. Future development programmes are to be coordinated to permit most effective utilization of engineering capacity. In March, Wilcox acquired licence production rights for Ekco airborne weather radar equipment.

De Havilland Aircraft Company (HSG) is laying down an initial production batch of 30 DH.125 6-8 seat twin-jet executive transports. Powerplant two rear-mounted Bristol Siddeley *Viper 20* engines of about 3,000-lb take-off thrust (developed from *Viper 11*). Accommodation will be provided for two crew and eight passengers with normal airline seating. First flight is likely in 1962 and deliveries in 1963.

British Aircraft Corporation has dropped the VC.11 four-engine passenger transport, but will now go ahead in the small short-haul jet field with the 48–60 seat BAC.107 (twin BS.75s) and the BAC.111 (two RB.163 *Speys*). Main emphasis in the current sales drive is on the BAC.111, tailored for quick turn-around on short-haul high-frequency services and aimed particularly at the U.S. and Australian markets where there is already reportedly considerable airline interest.

Trans World Airlines is reportedly sending a study team to Sud-Aviation's Toulouse facility to evaluate the *Caravelle*.

West Germany's aircraft industry employed 16,240 technicians and workers on airframe construction at the beginning of this year. During 1960, 20.1 million man-hours were worked, and the industry's turnover totalled DM 283.5 million ($70,875,000) compared with a 1959 figure of DM 147.8 million ($36.95 million).

AFITA (Association Française des Ingénieurs et Techniciens de l'Aéronautique) will hold its 5th International Aviation Conference at Le Bourget May 29th–June 1st at the time of the Paris Air Show. The theme is "Nouveaux Matériaux pour l'Aéronautique," sponsored by USIA.

General Precision Inc. (the operating subsidiary of General Precision Equipment Corp.) has signed a cross-licensing agreement with the West German industrial controls manufacturer Schoppe und Faeser, a subsidiary of Hartmann und Braun (Frankfurt). The two companies are to exchange design, manufacturing and application technology for the automatic control of plant processes. General Precision will add new sensors, controls and actuators based on Schoppe und Faeser's developments.

Bristol Siddeley Engines Ltd. has cancelled its agency agreement with Luftfahrt Technik GmbH of Düsseldorf, and the British company's aircraft engine interests are now being handled by Powell and Co. AG of 1 Kapellenstrasse, Bad Godesberg.

Artist's impression of the new DC-8F Jet Trader *offered by Douglas Aircraft for service at end 1962. Engineering is under way, and first flight is scheduled for August 1962. The new combined cargo-passenger version of the DC-8 will have a layout for up to 52,000 lb of cargo occupying two-thirds of the cabin, plus 54 tourist or economy passengers in the aft section. Estimated price about $6.5 million.*

Walter Kidde GmbH will supply fire detection and extinguishing equipment for the twelve Boeing 727s on order for Lufthansa. The German company is also supplying similar systems for the new ocean-going hydrofoil designed and manufactured by Dynamic Developments Inc. (an affiliate of Grumman Aircraft Engineering Corp.)

MILITARY AFFAIRS

The United States will build up a force of almost 1,300 intercontinental or equivalent-range ballistic missiles by early 1965 under the revised defence programme announced by President Kennedy. Total will include 600 *Minuteman* weapons in dispersed underground silos, 464 *Polaris* missiles installed in 29 submarines, 126 *Atlas* ICBMs and 108 *Titan* ICBMs of storable and non-storable variety. The ballistic missile force thus contemplated totals 1,298 weapons, exclusive of the *Skybolt* ALBM which is scheduled to enter operational service in 1964 aboard SAC's B-52H bombers.

Ryan Aeronautical Company's Aerospace Division has an initial Air Force letter contract authorizing preparation of 110 Q-2C *Firebees* for the 9th World Wide Weapons Meet. The programme is expected to exceed $1.8 million. The Q-2C will be the principal jet target missile at the Weapons Meet (William Tell 1961) scheduled for October 16th–26th at Tyndall AFB in Florida.

The West German Army is to be equipped with the Bö 810 *Cobra* weapons system, following completion of operational testing. The *Cobra* is an anti-tank missile with a range of 1,800 meters (1 mile).

The U.S. Navy's newest light attack aircraft, the Grumman A2F-1 Intruder, *is pictured here with a total of thirty 500 lb bombs mounted in clusters of three from wing stations. The two-seat* Intruder *is an allweather aircraft for carrier operations on close ground support missions for tactical forces. The* aircraft *can also carry nuclear weapons.*

The U.S. Army is expected to place an order for French anti-tank missiles in the near future, according to a Pentagon statement. Weapons under consideration are the DEFA *Entac* and Nord-Aviation SS.11. U.S. sources say that the Army contract for equipping infantry divisions with French ground-to-ground missiles could be the largest to date. In 1959 the U.S. Army gave Nord a $11 million order for the SS.10, and this weapon is in service with U.S. forces in Germany and elsewhere. The SS.11 can be operated from a jeep or helicopter and has a 3,500 yd groun range. The DEFA *Entac* has a range of approximately 2,200 yd and can be operated by one infantryman. The 1959 contract also included a number of experimental SS.11 weapons which have been tested at the Fort Rucker, Ala. firing range.

AIRCRAFT

NASA test pilot Joe Walker, flying the North American X-15, reachedan absolute altitude of 169,600 ft, after release at an altitude of 45,000 ft, on March 10th. This is the highest altitude ever reached by a manned aircraft. (The present official world altitude record of 103,390 ft was set by Captain Joe B. Jordan on December 14th, 1959 in a Lockheed F-104C *Starfighter*, although an X-15 reached an altitude of 136,500 ft last year). The maximum speed during the flight was 2,756 m.p.h., corresponding to Mach 3.95. After landing at Edwards Air Force Base, California, Walker said that he used only two thirds of the power of his rocket engine (powered phase 79 seconds) and climbed without power from 110,000 ft upwards. Walker was weightless for about 90 seconds of his ten-minute flight, but felt no discomfort. North American has proposed the use of two-seat X-15s for the training of astronauts.

The LASA 60 multi-purpose aircraft made its first flight at Lockheed-Azcarate SA's San Luis Potosí facility, about 200 miles north of Mexico City, on March 21st. The aircraft, which is powered by a 260 h.p. Continental TSIO-470B engine, is being produced under licence by Aeronautica Macchi in Italy and Aviones Lockheed-Kaiser in Córdoba, Argentina.

Nord-Aviation has decided to build a pressure-cabin version of the *Super Broussard*, with the agreement of SGAC. This aircraft, to be known as the MH.262, will be produced parallel with the unpressurized standard version (MH.260), enabling either version to be built

Production of first twin-turbine Boeing-Vertol helicopters is now in high gear at Vertol's Morton (Pennsylvania) plant. On the left of the picture are two Boeing-Vertol 107 transport helicopters. On the right, the first three YHC-1B Chinooks *for the U.S. Army. Both* Chinook *and 107 have straight-end, rear-loading ramps and production-sealed fuselages. Delivery of both types will begin later this year.*

The new Hiller E4 four-seat helicopter is powered by a 305 h.p. Lycoming VO 540 engine with dual carburation for added power at high altitudes. Hiller is offering the E4 from the production line or as a conversion kit for the model 12E three-seat helicopter to E4 configuration.

The Hiller tilt-wing VTOL X-18 is undergoing flight testing at Edwards AFB. Wing angle of attack of 50° has been reached during the first phase of flight testing. This summer the X-18 will enter a new phase of testing to examine the effects of propeller downwash on ground environment during simulated hovering conditions.

to meet requirements at any given time. Apart from the pressurized cabin, the MH.262 is said to be identical to the MH.260.

The Morane-Saulnier MS.880 Rallye-Club has begun official type certification test flights at the Brétigny Flight Test Centre; for these, the second prototype, powered by a 100 h.p. engine and corresponding to the production version, is being used. From its first flight on February 10th, 1961 to the time of its transfer to Brétigny the aircraft made 65 take-offs, logging over 40 hours total flying time. Certification flights are expected to last about six weeks. The third prototype—which is the first MS.885 *Super-Rallye*, powered by a 145 h.p. engine—was scheduled for test-flying in mid-April, after which it was to go to the USA for demonstrations.

A Minuteman *ICBM housed in this 63-ft long truck container is raised to a vertical position by two erector-actuators during first public demonstration of the emplacement system at Bendix-Pacific Division, North Hollywood. A hydraulically-powered hoist capable of handling 50 tons lowers the missile gently into its underground launch site. Control is from the panel at lower right in picture. Bendix designed and built the emplacement system.*

Production of the Hindustan Aircraft HT-2 two-seat trainer has been phased out after the completion of 160 aircraft. The aircraft, manufacture of which began in 1953, is used for basic training by the Indian Air Force and Navy and is in service with aero clubs; twelve were recently delivered to Ghana. The HT-2 is powered by a 155 h.p. *Cirrus Major III* engine, is of all-metal construction, reaches maximum speeds of around 110 knots, has a service ceiling of 14,500 ft and an endurance of 3.5 hours.

The Hindustan Aircraft HF-24 Mach 2 fighter, powered by two Bristol Siddeley *Orpheus BOr.12* jet engines, has begun flight tests, according to agency reports.

ENGINES

The British Air Registration Board has authorized a 2,600 hour overhaul life for the Rolls-Royce *Avon RA.29/1 Mk.524B*, installed in BOAC's de Havilland *Comet 4s*. The latest increase continues the rapid extension of overhaul life which the *Avon* has steadily maintained since it entered service with BOAC in 1958 with an overhaul life of 1,000 hours. BOAC's *Avons* are increasing their total running time, which is at present over 439,000 hours, at a rate of some 5,000 hours a week. All *Avons*, both civil and military, have logged well over 3.5 million hours of operation.

General Electric reports that the new CJ-805-23C turbofan engine has received FAA type certification; take-off thrust is quoted as 16,100 lb. The engine will power the Sud Aviation *Caravelle 7*. It differs from the CJ-805-23 installed in the Convair 990 only in the arrangement of the external plumbing and engine-aircraft mounts.

The U.S. Navy has approved the 150 hour qualification test of the Boeing 270 s.h.p. T50-BO-4 helicopter engine. First production use of the T50 will be in the Navy DSN-3 drone helicopter built by Gyrodyne Company of America. The T50 has met the required specifications of 270 s.h.p. at an exhaust gas temperature of 1,140°F.

ASTRONAUTICS

Soviet scientists successfully launched their fifth space vehicle with a pressurized cabin containing a dog on March 25th, according to the Soviet news agency Tass. The final stage of the vehicle and the capsule went into an earth orbit with a perigee of some 110 miles and an apogee of 153 miles, the orbital period being 88.4 minutes and the angle of trajectory 64°54′. The capsule containing the experimental animal was subsequently recovered.

A further Mercury capsule was launched by *Redstone* booster from Wallops Island, Virginia, on March 25th. The capsule, which carried no scientific equipment, was not recovered. According to NASA reports, the firing was successful; the peak height was 115 miles, and the capsule came down in the Atlantic 310 miles from the launching site.

On the same day, NASA scientists launched the *Explorer 10* research satellite into a highly elliptical earth orbit by *Thor-Delta* three-stage booster. The satellite was designed to take measurements of the cislunar magnetic field, for which purpose it carried an ultra-sensitive rubidium vapour magnetometer weighing only 24 oz. According to NASA information, *Explorer 10* reached its apogee of 112,500 miles on March 27th. The measuring equipment and transmitters worked satisfactorily, and the transmitted data were clearly received by the three ground tracking stations at Goldstone, Calif., Jodrell Bank, England and Woomera, Australia. Contact was lost at 1500 GMT on March 28th, as *Explorer 10* was passing the earth at a speed of 24,000 m.p.h. and an altitude of only 110 miles. Its batteries had gone dead a few hours earlier.

The Transit 3B navigation satellite burnt up on the morning of March 30th as it re-entered the denser layers of the earth's atmosphere, having remained in orbit only 38 days instead of three years, as originally planned. *Transit 3B* and the *Lofti* radio research satellite were launched from Cape Canaveral on February 21 st. The final stage and the two satellites did not separate as planned, and instead of a circular orbit with an average height of 500 miles a highly elliptical one, with an apogee of 617 miles and a perigee of 104 miles, was achieved.

Tokyo University scientists launched a two-stage *Kappa-8* research rocket from Michikawa, Akita Prefecture, on March 27th. The climb to a height of 106 miles lasted six minutes and 50 seconds; the second stage fell into the Sea of Japan about 150 miles from the launching site. A number of precise data on conditions in the ionosphere were collected.

The first *Kappa-9* research rocket was successfully launched from Michikawa on April 1st. The three-stage rocket has an overall length of 41 ft and weighs some 3,370 lb. It reached an altitude of 220 miles. →→

Stuttgart Airport's full 7,400 ft runway 08/26 was scheduled for inauguration on April 21st. Picture shows construction work in progress earlier this year. Overrun strips of 720 ft and 360 ft are provided at the western and eastern ends of the runway.

Rockets, Missiles and Space Vehicles

Saturn Development

The National Aeronautics and Space Administration has made a substantial modification to the *Saturn C-1* booster rocket. Douglas has received orders to fit the S-4 second stage not with four Pratt & Whitney LR-119 rocket engines of 17,500 lb thrust (originally, four LR-115s of 15,000 lb thrust each were planned), but with six LR-115s, mainly because development of the LR-115 is considerably farther advanced than that of the LR-119. Both engines use liquid hydrogen and lox as propellants. The modification is not expected to delay the first launching of the *Saturn C-1* with live second stage, which is scheduled for 1963.

Further Discoverer Attempts

The attempt to place the *Discoverer 22* research satellite in orbit at the end of March was a failure, despite the fact that the *Thor-Agena* booster was launched according to plan. The reasons for the failure had not yet been made public at the time these lines went to print. The U.S. Air Force's intention was to guide the satellite accurately into a polar orbit by a radio system in the second stage of the booster, and to have the instrument capsule recovered by aircraft in the region of Hawaii. The instrumentation of *Discoverer 22* was designed mainly for cosmic ray research. The satellite also carried heart and brain tissue from an unhatched chick, human bone marrow, algae and other forms of life.

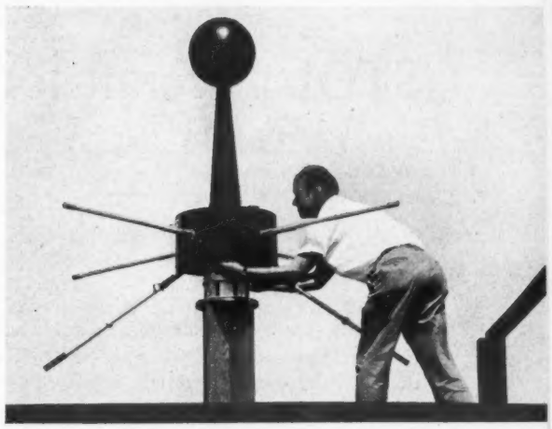
On April 8th the U.S. Air Force placed the *Discoverer 23* in a polar orbit, using a *Thor-Agena B* as booster: apogee 402 miles, perigee 186 miles and orbital period 94 minutes. Owing to instability in the satellite and a resultant error in attitude, the capsule could not be returned to earth after two days in orbit, as planned. It was, however, ejected and is now on a separate orbit from the satellite.

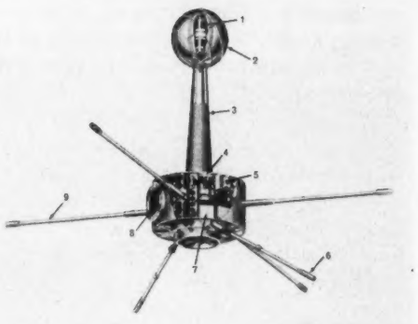
Bofors Erika Anti-Submarine Rocket

The *Erika* anti-submarine weapon, manufactured by Aktiebolaget Bofors, Sweden (see sectioned drawing), is claimed to have very little dispersion. Its rocket powerplant gives it velocities of 330 to 430 ft/sec. At present equipped with a mechanical time fuse, it will later be fitted with a proximity fuse. The *Erika's* four-barrel launcher weighs 16,310 lb, the elevating limits for firing are +15° to +60° and the field of traverse 264°. The loading time for four barrels is 2.5 to 3 minutes and the minimum firing interval one second.

New French Research Rockets

At the second COSPAR space research conference held at Florence in mid-April, Paul Muller, Director of the Satellite Section of Meudon Observatory, reported on new French research rockets. The *Antarès* rocket, developed by Office National d'Etudes et de Recherches Aéronautiques (ONERA), has been used to investigate heating of nose cones on re-entry into the denser layers of the earth's atmosphere at speeds of around Mach 7. Later this year, *Bérénice* research rockets will be fired from Hammaguir; the *Bérénice* is a four-stage rocket, 46 ft long and weighing 6,600 lb, developed from the *Antarès*, which can carry a 132 lb scientific payload to an altitude of 590 miles. The *Bélier* and *Centaure* rockets developed by Centre National d'Etudes des Télécommunications (CNET) and Sud Aviation are already in production; these can carry a 70 lb payload to altitudes of 50 miles and 87 miles respectively. Muller also mentioned the *Dragon* research rocket, which can carry a 70 lb payload to an altitude of 250 miles. Finally, the *Pégase*, a joint development of CNET and Sud Aviation, is designed to take a 70 lb payload to a height of 620 miles.

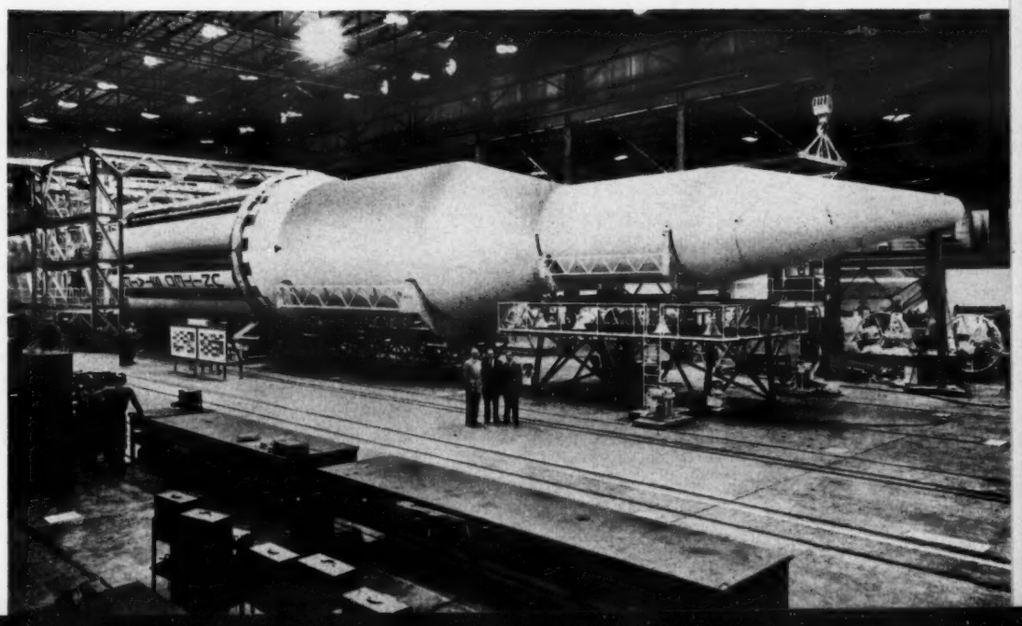




The *Explorer 10* earth satellite for investigation of the cislunar magnetic field (cf. page 706 of this issue). Height 52 in.; diameter at base 19.36 in.; antenna span 85 in.

1 – rubidium vapour magnetometer;
2 – bias sphere;
3 – support tube;
4 – turn-on plug;
5 – optic aspect;
6 – fluxgate sensor;
7 – electronic modules;
8 – plasma probe;
9 – antenna.

◀ Section through the Bofors *Erika* anti-submarine rocket. Overall length 78.7 in.; launch weight 550 lb; maximum range at approx. 160 ft depth 1,800 yd; TNT charge 220 lb, Hexotonal charge 235 lb.



Saturn C-1 booster, here with the S-1 first stage and mockups of the S-4 second stage and S-5 third stage. A *Saturn* is to make its first flight in this form at the end of 1961, according to NASA.

STOL Aircraft for Short-Haul Transports

by H. Ziegler,
Managing Director, Ateliers d'Aviation Louis Breguet, Paris

For fifty years, aviation has devoted its greatest efforts to the development of its most outstanding characteristic—speed. In certain instances, this has been obtained at the cost of some other characteristic; in particular, the distance required for take-off and landing. The results achieved, dazzling as they are, should not make us lose sight of a somewhat paradoxical aspect of this development.

As speeds have increased, the number of suitable airfields has tended to diminish, by reason of the enormous costs involved in their construction. In consequence, the potential market for air travel tends to be limited to the inhabitants of the larger towns and to those who are of necessity compelled to travel to the large towns by other means, preparatory to making a long-distance air journey.

The overwhelming majority of short-distance journeys originate in all parts and not merely in the large cities. It would therefore be true to say that today the great majority of the population is still unaware of all the advantages of using the air for its journeys. With the appearance of STOL aircraft, present-day techniques are on the threshold of supplying a practical, safe, and economic solution to this problem.

*

French developments, the Breguet 940-941-942 and 945 blown wing STOL transports

Since 1948 the Société Breguet has conducted extensive studies and experiments into the problem of short take-off and landing for aircraft of relatively high cruising speeds.

A variety of solutions has been subjected to systematic investigation, namely:

- Wing blowing
- Flap blowing
- Super circulation
- Rotors faired into the wings
- Tilting wings
- Tilting engines.

These studies have shown that a satisfactory compromise, which is both practicable and capable of achievement without major difficulty, can be obtained by the blowing of a fixed wing. This powerful high-lift force is obtained by the slipstream from four interconnected propellers installed so that the slipstream covers the entire span of the wing. To put this aerodynamic principle to the test, the Breguet 940 was developed.

This conception lies midway between the conventional aircraft and the helicopter. The machine is supported by its wing, like a normal aircraft, and also by the air flow from the propellers which is deflected downwards by large flaps, like a helicopter. The combination of these two effects enables the take-off and landing distances to be reduced, while permitting cruising flight under the same conditions of speed and safety as provided by the conventional aircraft.

The main characteristic of this aircraft is its ability to take off and land on makeshift and small airfields. For the type 945, the take-off distance to clear a 50-ft obstacle is 650 ft at sea level and 1,000 ft at 3,500 ft altitude and 40°C. The landing distance is 190 ft in the first case and 240 ft in the second.

Furthermore, these aircraft have a turning radius of the order of 250 ft at speeds below 45 kts, which indicates excellent low-speed handling qualities. This is a great advantage when making an approach in confined and mountainous regions.

The Breguet system for a blown wing also offers four vital safety factors:

— In the event of engine failure at take-off, there is no loss of controllability. The loss of power is less than half, as the more lightly loaded propellers have an improved performance;

— During the approach, the descent can be made three or four times more steeply than with a normal aircraft. This gives a greater safety margin for the clearance of obstacles;

— On landing, the rapid change into reverse pitch and the power of the propellers reduces the landing run considerably, even on wet or slippery surfaces;

— As the approach is made under power, changing the propeller pitch gives immediate response if the landing is baulked and it is necessary to go round again. The flaps can be raised immediately to reduce the drag, so that acceleration is considerably greater than that of a normal aircraft.

Breguet now possesses a fund of experience gained from extensive research work, including:

— Numerous wind tunnel tests with powered models of the BR.940, 941, 942, and 945, and also free-flight tests in the Chalais-Meudon wind tunnel with wire-controlled, powered models of the Breguet 940 and 941;

— Three years of flight trials and more than 300 hours of flying carried out with the prototype BR.940. These tests have provided a thorough exploration of all the phases of STOL flight and have resolved the problems of flight control at low speeds;

— The bench testing of a transmission shaft, followed by the complete test of the four-engined power unit;

— The construction of the prototype BR.941.

The flight tests of the experimental prototype BR.940 have been long and exhaustive, as the complete exploration of all the flight phases involved a large number of parameters, some of which were entirely new. These included such features as the interconnection between the differential pitch control of the propellers and the aileron controls, and air braking by use of the outer propellers.

To our knowledge, it was the first time that such an exploration of these aerodynamic condi-

Prototype of the Breguet 941, powered by four Turboméca *Turmo IIID* propeller turbines, each rated at 1,250 h.p. for take-off, with Ratier-Figeac coupled propellers.

tions had been carried out anywhere in the world, and it was essential that the trials were conducted with the utmost method and prudence. Furthermore, the control system based on four different propeller pitch settings demanded rigorous development.

The results achieved have more than confirmed the forecasts, for at an all-up weight of 15,400 lb, the Breguet 940 can take off and clear a 50-ft obstacle in 600 ft (ground roll 260 ft). For landing over similar obstacles, distances of 510 ft have been achieved (ground roll 190 ft).

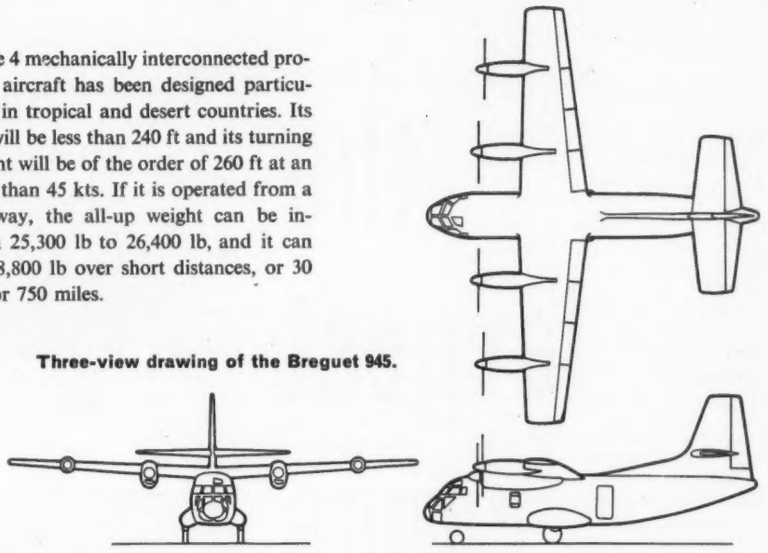
Based on this formula for a blown wing, the following types have been established.

The Breguet 941, the prototype of which is currently undergoing trials. This is a freight or mixed freight and passenger aircraft, powered by four Turboméca *Turmo IIID* turboprop engines. The all-up weight is 44,000 lb and the payload 11,000 to 13,200 lb. The aircraft has a range of 1,250 miles at a cruising speed of 250 m.p.h.

The freight version is fitted with a large rear-loading ramp, permitting the loading of vehicles or large dimension loads up to 41 ft in length. In the military version, these loads could include such items as GMC trucks, armoured cars, artillery equipment, surface-to-air and surface-to-surface missiles, dismantled light tactical support aircraft, or 40 men in battle order. This aircraft can operate from improvised landing strips, 1,000 ft in length.

The Breguet 942 is the pressurized version of the 941 and is designed for the transport of 50 to 60 passengers. The wings and power units are identical to those in the 941. Two entrances have been fitted, one on the port side forward for cargo and passengers, the other on the port side rear for passengers only. The simultaneous use of the two doors permits accelerated loading and unloading, an important factor in transport economics, particularly when the journey includes intermediate stops. Allowing for commercial safety margins, this aircraft can operate from runways 1,300 ft in length.

The Breguet 945 is a light transport aircraft with an all-up weight of 22,000 lb, and is capable of carrying a payload of 3,300 lb over a range of 900 miles at a speed of 250 m.p.h. Two *Turmo IIID* engines, identical to those installed in the BR.941, drive 4 mechanically interconnected propellers. This aircraft has been designed particularly for use in tropical and desert countries. Its ground roll will be less than 240 ft and its turning radius in flight will be of the order of 260 ft at an airspeed less than 45 kts. If it is operated from a 1,300-ft runway, the all-up weight can be increased from 25,300 lb to 26,400 lb, and it can carry up to 8,800 lb over short distances, or 30 passengers for 750 miles.



Three-view drawing of the Breguet 945.

These types of aircraft with short take-off and landing characteristics represent a revolutionary stage in the technique of air transport, and they can be utilized equally well in either military or civil applications. In the military field, the Breguet 941 and 945 represent the first really practical and efficient tactical transport aircraft that can be brought into action quickly and at short notice or used for transport and supply missions. In the civil domain, the Breguet 941, 942 and 945 fulfil a wide range of requirements as either freighters or passenger aircraft.

The benefits of air transport will be extended to innumerable centres of population, without incurring the heavy expenses of constructing ground facilities. In France, as an example, there are only six airports with runways longer than 8,000 ft and 26 with more than 4,800 ft of runway. At the same time, there are more than 300 airfields which can, as they stand, accept this type of aircraft.

These aircraft will be called upon to play an important role in Africa and in all countries in the process of development. Owing to the wide variety of civil applications, including transport both in brush and mountainous country, oil and mineral prospecting, forest protection etc., they will make an effective contribution to the economic development of these countries.

For countries already possessing long-distance air routes and extensive surface transport systems, the Breguet 941, 942 and 945 will be the feeder aircraft supplementing the long-distance routes. They will be able to serve a large number of centres which already possess a small airfield some 1,000 ft in length, but which, for financial or geographical reasons, will never possess an airfield capable of accepting a normal high-speed aircraft. This applies particularly to island air services and to townships in mountainous areas.

It must be agreed that the special features of these aircraft are reflected in the higher purchase price. But the saving in expenditure on ground organization, together with the flexibility and the regularity of operation, compensate for the initial outlay.

The STOL aircraft will be an important factor in the development of the economic life of those countries which are potentially rich but unexploited through lack of surface transport. For this reason, an enormous increase in the air transport market can be anticipated. We believe that it would not be an exaggeration to say that we are on the threshold of sweeping changes, which will affect not only the aeronautics, but the economies of countries throughout the whole world, and even the military and political aspects of their existence.

BREGUET 945

Span	67.32 ft
Length	54.78 ft
Height	24.09 ft
Wing area	595.2 sq. ft.
Freight hold capacity	777 cu. ft.
Payload at a gust load factor of 3.5	3,300 lb
Payload at a gust load factor of 2.5	7,700 lb
Take-off weight	22,000-24,000 lb
Powerplant : two Turboméca *Turmo IIIDs*, each with a take-off rating of	1,250 h.p.
Four Ratier-Figeac coupled propellers, diameter	12.54 ft
Cruising speed	250 m.p.h.
Range with 3,300 lb payload and take-off weight of 22,000 lb	1,000 miles
Take-off roll [1]	330 ft
Take-off distance over 35 ft screen [1]	660 ft
Landing roll [1]	200 ft
Landing distance over 50 ft screen [1]	530 ft

[1] sea level, standard atmosphere, still air

A model of the Breguet 941 being prepared for free flight tests in the large ONERA wind tunnel at Chalais - Meudon. The electrically powered model can be remotely controlled from a console, whose controls exactly simulate those of a 941 cockpit.

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DFS 582 High-Altitude Research Aircraft

The Aeronautical Research Institute of Munich (formerly the German Gliding Research Institute) has published official details of the DFS 582 jet-powered sailplane for high-altitude research, which is being developed for the study of jet streams under contract to the German Federal Ministry of Transport. The basic requirements of the project were powered take-off; climb to 46,000 ft in about 30 minutes; powered cruise for 135 n.m.; unpowered research flight (rate of descent at 46,000 ft altitude approximately 490 ft/min, at low altitude approximately 220 ft/min at 65 knots); maximum endurance about 5 hours; glide back to base or to another selected airfield (instrument landing also possible); reserve fuel for at least 30 minutes; taxiing under own power. These resulted in the following design requirements: 1—ability to take off under own power; 2—two-seat pressurized cabin; 3—gust load factor of 12; 4—high-quality aerodynamic surfaces; 5 — instrument payload of 220 to 440 lb; 6 — easy to dismantle for transport on land or by water.

These requirements crystallized into the DFS 582 design, which was based on experience gained from previous work (DFS 54 and DFS 228). The designers were, however, not able to draw on experience from other countries such as France (Breguet S-10) or the USA, so that all problems had to be investigated right from the beginning.

All the main support surfaces are of sandwich construction. The plastic-covered fuselage nose contains the nosewheel, a number of automatic measuring instruments and the battery; behind it is the pressurized cabin with the main instrument chamber. The fuselage centre section is a light-metal monocoque with a number of cutouts. The lateral air intakes with de-icers are closed for gliding flight. The tubular fuselage rear, which is of simple sandwich construction, contains the jet pipe and supports the tail, which is also of sandwich construction. The twin-wheel undercarriage is a single-track type with supporting wheels on the wings, and can be braked. The control surfaces are actuated by push-rods without power assistance.

Wing design posed a number of problems as regards the requirement for good stall characteristics in slow flight; these were solved by the choice of a suitable airfoil and wing planform. The critical speed for the airfoil is Mach 0.6 and determines the maximum speed of 340 knots at 46,000 ft. The wing is of bonded sandwich construction and is built in four parts. The breaking strength of the aluminium/zinc alloy sheets to be used is approximately 80 tons/sq.in. The ailerons are fitted outboard, the cambered flaps inboard.

The choice of engine was dictated by the following requirements: 1—it must not impair the aircraft's performance in unpowered flight (minimum drag); 2—low weight and small dimensions; 3—reliable high-altitude ignition, even when cold; 4—ease of maintenance. The final choice fell on the Pratt & Whitney JT-12A6 of 3,000 lb thrust and 500 lb dry weight.

Dimensions and design performance figures are as follows: length approx. 56 ft; span approx. 98 ft; wing area 495 sq.ft.; aspect ratio 20; average wing loading 15.4 lb/sq.ft.; NACA 64_3-618 airfoil; empty weight 5,730 lb; useful load 1,720 lb, including 1,100 lb fuel; gross weight 7,720 lb; maximum speed 300 knots; minimum speed, flaps down, 45 knots; sea level rate of climb approx. 3,070 ft/min; time-to-climb to 46,000 ft about 32 minutes.

The aircraft equipment includes complete blind flying instrumentation; a flight director is being developed by Perkin-Elmer. No navigation system has yet been selected. The pressure cabin is being developed jointly with Normalair and can be filled with up to 100% oxygen, according to requirements. Oxygen masks and pressure suits are supplied for emergency use. Oxygen is supplied from a 1.1 Imp.gal. vaporizer with a closed circuit between cabin and vaporizer, and is adequate for a seven-hour flight. The pressure cabin altitude is 24,600 ft.

The possibility of building the DFS 582 was discussed with nearly all German aircraft manufacturers, and finally Weser Flugzeugbau GmbH, of Bremen, declared itself willing to undertake construction under a partially State-funded contract. Two aircraft are initially being built, and these are to fly in summer, 1962.

As regards the further applications of the DFS 582, the Ministry of Nuclear Energy and Water Power has shown an interest in the aircraft for measurements of high-altitude radiation. In addition, the DFS 582 could perform a wide variety of aerial survey tasks.

Book Reviews

Fabrication des avions et missiles. — By M. P. Guibert. — Dunod, Paris, 1960 (second edition revised and enlarged; French; 848 pages, 693 illustrations; cloth-bound; price 125 NF).

Reviews of this volume have already appeared in several journals. All have welcomed it as an outstanding work, and this opinion can only be endorsed here. Where else, indeed, can the engineer, technician or executive find such a mine of information about all aspects of aircraft manufacture (and many other industries besides)? All phases of manufacture are dealt with, starting at the earliest planning stage and working through to final assembly and production control (the latter is, however, somewhat briefly covered). Production planning and organization, timing questions, the actual commencement of production, tooling, various manufacturing processes and assembly operations are amongst the subjects covered. Ultrasonic welding, chemical milling and arc-cutting are amongst current techniques described with illustrations, which abound throughout the volume and are very well chosen.

The last part is devoted to the development of aeronautical production, new materials, newly perfected processes and particularly missiles and ballistic vehicles and all their special production techniques.

This is a work which should unquestionably have its place in all technical libraries. M. J.

Dictionary of Electronics. — By Harley Carter. — George Newnes Ltd., London, 1960 (English; 384 pages; 232 illustrations; price 35s.).

Electronics has received such an impetus in the last few years that it is often hard even for an expert to follow developments. New knowledge and its application in modern equipment make it necessary for new words to be coined continually. Moreover, more and more electronic equipment is being used in all branches of research, industry and economics. Many users need to acquaint themselves with at least the principles of their new equipment. It was these considerations which gave rise to the present dictionary. In the choice of material, particular importance was attached to the basic terms of electronics. These are explained concisely and exactly, and the many diagrams, the clarity of which deserves special praise, simplify the understanding of often difficult ideas. The abbreviations, symbols, conversion tables etc. given at the end of the book are likewise very useful. This well-arranged volume is handy in size, and the type face is pleasing. Eb.

Dictionary of Automatic Control. — By Robert J. Bibbero. — Reinhold Publishing Corporation, New York, 1960 (English; 282 pages; price $6.00).

Over 500 definitions of technical terms used in all fields of automatic control are contained in this volume, which is distinguished by its exceptional clarity. Numerous cross-references to basic terms are indicated in capital letters in the text of the definitions. If, on the other hand, the meaning of a technical term is already explained in the definition of another term, it is printed in italics; in its alphabetical position there is merely a reference to the other term, where the italic print enables it to be rapidly found. The index at the end of the book is divided into five sections: Control Theory and Basic Concepts; Computers and Data Processing; Industrial Machine and Process Control; Aircraft/Missile Control and Telemetering; Control Components and Design Factors. The definitions are written in a clear and comprehensible style, making the dictionary invaluable not only to the engineer and the technician, but also to the student and the layman. Eb.

Elektronische Analogrechner. Wirkungsweise und Anwendung. — By Dietrich Ernst. — R. Oldenbourg Verlag, Munich, 1960 (German; 315 pages; 227 illustrations; price DM 38; cloth).

German technical literature so far includes few usable books concerning electronic computer systems. The appearance of this work is all the more welcome as this is the first time a comprehensive introduction to the functioning and applications of electronic analogue computers is available in German, a work which moreover assumes no special knowledge in this field on the reader's part. In order clearly to define the position of the analogue computer, the author deals in the first chapter with the basic principles of the analogue and digital systems. The next two chapters give a complete description of the construction and functioning, as well as the programming, of electronic analogue computers. There are six examples of how to deal with problems in practice, including the solution of partial differential equations and explanations of numerous knacks in programming. These are followed by two chapters about further applications and preparation of special problems for input into the computer. The final chapter constitutes an exhaustive description of analogue computers by 16 manufacturers in six countries with interesting details about their functional and constructional design. A copious bibliography and an index contribute to the comprehensive nature of this work, which should be of great value not only to physicists, engineers and students, but can also be recommended to anyone interested in the techniques and applications of modern analogue computers. Eb.

Fundamentals of Aerodynamic Heating. — By Robert Wesley Truitt. — The Ronald Press Company, New York, 1960 (English; 257 pages with numerous tables and diagrams; price $10.00).

In order to facilitate understanding of the later chapters, the author starts with a condensed exposé of laminar and turbulent boundary layers, skin friction and heat transfer. This is followed by detailed consideration of aerodynamic and thermodynamic

phenomena encountered in flight at high speeds. Hypersonic flows of low density media—where the continuum theory is no longer valid—are in the forefront of the author's treatment of his subject. Three final sections are devoted to heat transfer in the region of stagnation point, mass-transfer cooling and the calculation of skin temperature. References are given at the end of each chapter, and a series of problems and answers precedes the index.

This systematic and detailed book which, despite the difficulty of the material, is lucidly written, is intended in the first place for the student, but will also be valuable for engineers, physicists and mathematicians concerned with missile development problems. Knowledge of higher mathematics is indispensable for understanding of the material. Ge.

Analyse dimensionnelle. — Julio Palacios; translated from the Spanish by Jean Prévot. — Gauthier-Villars, Paris, 1960 (French; 200 pages; price NF 40 or $8.50).

The author, who has already published a number of works on physics, here presents a new method of dimensional analysis which, as he remarks himself, "contradicts the ideas of many authors... and even philosophical doctrines accepted by the majority of contemporary physicists." In the first part, which occupies some 40 pages, he deals with the theory of homogeneity of functions and equations, enumerates the physical entities and sets forth the postulates from which he has evolved his method: the fundamental laws of physics and the determination of universal constants. These enable him to clearly define the concept of dimension and the theorem of π. The second part, by far the more important, is devoted to the practical applications of his theories. After explaining how problems must be posed, a procedure which often presents considerable difficulties, the author cites numerous examples taken from a wide variety of sciences: mechanics and the resistance of materials, fluid mechanics, aerodynamics, thermodynamics, statistical mechanics, quantum and relativistic mechanics, electromagnetics and nuclear physics. A list of universal constants, a bibliography and an alphabetical index complete this work, which clearly explains mathematical theories to the practical man, offering him a new tool for his work. J. P.

Météorologie — Cours pour aviateurs. — By W. Eichenberger. — Schweizer Druck- und Verlagshaus AG, Zurich, 1960 (French edition; 326 pages, 200 illustrations; cloth-bound; price Sfr. 22).

If this book were not intended primarily for navigators and did not deal in its entirety with the problems of aviation, it is so clear, practical and precise, giving only as much theory as is necessary to understand natural phenomena, that it might be termed a work of vulgarization. The text is illustrated by numerous diagrams, which make it highly readable even for the layman.

It therefore comes as no surprise to learn that the author is not only a highly qualified scientist, but has also a great deal of practical experience. For many years an official of the Federal Air Office at Berne, he has also been an airfield meteorologist and is a qualified pilot.

This very complete work deals in detail with all current questions of aeronautical meteorology, including altitude charts, jet streams and pressure-pattern navigation. The author devotes particular attention to phenomena dangerous to aviation, indicating means of avoiding these and the safety measures to be taken. The book also describes the method of operation of air meteorological services, and an appendix contains the codes and abbreviations used, together with some well chosen photographic plates. A questionnaire to check the knowledge of navigators and an alphabetic index complete the work, whose German edition has proved highly successful. M. J.

La Mécanique du Vol. Performances des avions et des engins. — By L. George and J. F. Vernet. — Librairie Polytechnique Ch. Béranger, Paris, 1960 (French; 465 pages, 344 figures and 17 tables and graphs; cloth-bound; price 98 NF).

This volume, which is prefaced by Pierre de Valroger, Director of the Ecole Nationale Supérieure de l'Aéronautique, forms the first part of the school's flight mechanics course and deals with the performance of aircraft and missiles. The authors, both of whom are aeronautical engineers, have aimed at giving their pupils a practical grounding, and the book, which is probably the only one to unite in a single volume present knowledge on the design performance of aircraft and missiles, will be invaluable not only to pupils of the Ecole Nationale but also to all aeronautical engineers, who will find many indispensable pieces of information. There is a series of appendices showing graphical and numerical methods of calculation, and 17 tables and graphs at the end of the book will assist the reader in the practical application of his knowledge, enabling him to find the characteristic values necessary for the solution of a variety of problems.

"The present book fills an outstanding requirement" writes Pierre de Valroger in his preface, and the editors are convinced that both students and engineers cannot fail to benefit from the assistance which it offers in improving their aeronautical knowledge. M. J.

DH — An Outline of de Havilland History. — By C. Martin Sharp. — Faber & Faber, London, 1960 (English; 419 pages, 171 illustrations; price 42/-).

Almost exactly fifty years after the first flight of Geoffrey de Havilland, the history of his work has been published. The author has taken pains to present the facts objectively, so that the reader can form his own opinion from the words and deeds of the men who, with Sir Geoffrey de Havilland, have made one of the world's best-known aircraft works what it is today. The book gives an excellent survey of the development of the de Havilland enterprise from the day in spring 1908, when de Havilland persuaded his grandfather to give him the money to build his first aircraft, to the development of *Blue Streak* and the DH.121 *Trident*. At the end of the book there are tables listing all the piston and jet engines, rocket motors and aircraft built by de Havilland. Eb.

Jahrbuch der Luftfahrt 1961 (10th issue). — Edited by Karl-Ferdinand Reuss. — Südwestdeutsche Verlagsanstalt GmbH, Mannheim, 1960 (German; 450 pages; plastic; price DM 14.80).

This yearbook of aviation, which is largely confined to West Germany, has for a long time been found on the desk of everyone connected with aviation. The tenth issue of this much-esteemed address and reference book has been expanded by 35 pages as compared with the previous year, and there has been a considerable improvement in clarity through the use of bolder headings. A thumb index, running titles and indexes by subject and names, as well as a list of contents at the head of each chapter, facilitate quick reference. The arrangement of the book into sections has in the main been retained. These are: aviation law; aviation authorities in the Federal German Republic; German aviation research and science; air transport; aviation industry; Club der Luftfahrt (German Aero Club); sports flying in Germany; aeronautical press and publishers; aviation in other German-speaking countries (Austria and Switzerland); civil defence; lastly a buyers' guide and subject index. Eb.

Vorstoss ins Unbekannte. Das grosse Abenteuer der Forschung im Internationalen Geophysikalischen Jahr. — By Werner Büdeler. — Ehrenwirth, Munich, 1960 (German; 356 pages with 100 photographs and 50 drawings in the texts; cloth bound; price DM 19.80).

Werner Büdeler, a young and well-known author of popular science works, has set himself a difficult task in this book. Nevertheless, he has succeeded in giving a fascinating insight into the realms of geophysics. Impeccably presented, the book should appeal to a wide public. The author, who has attended many international conferences, has had the opportunity to come into contact with a number of the scientists concerned with the programme of the International Geophysical Year, from whom he has received invaluable information.

Books like the present one make an important contribution in familiarizing the layman—particularly the young layman—with the scientific problems of our age and helping him to understand the necessity for costly research. Ge.

Einführung in die theoretische Gasdynamik. — Third, improved edition. — By Dr. Robert Sauer. — Springer-Verlag, Berlin/Göttingen/Heidelberg, 1960 (German, 214 pages; 210 illustrations; price DM 29.70).

The name of the author, who is Professor of Mathematics and Analytical Mechanics at the Munich Institute of Technology, is in itself a guarantee of quality. The third edition of his book, which first appeared in 1942, deals mainly with numerical methods, which are assuming growing importance with the increasing use of programme-controlled electronic computers in fluid dynamics. Also new are the chapters on asymptotic developments with respect to slender bodies and transonic and hypersonic flows.

Departing from the principles of physics and flow mechanics, the author next turns to linearized steady flow about profiles and rotating bodies, discusses non-linear problems concerning subsonic and near-sonic flows and deals in detail with the hodograph method (for two-dimensional vortex-free subsonic flows and near-sonic flows) and the characteristic method (for two-dimensional vortex-free supersonic flows). A further chapter is devoted to shock waves, and finally there is a chapter on three-dimensional, non-axially symmetrical steady flows. This book is essential for anyone whose work deals with high-speed aerodynamics. Ge.

Moderne Leichtbautechnik im Flugzeugbau und weiteren Anwendungsgebieten, Band I: Rumpf, Schalen- und Vollwandbauweise. — By Gerd Otto. — Friedr. Vieweg & Sohn, Brunswick, 1960 (German; 284 pages; 201 illustrations; price DM 24.80; paper).

In this highly practical book the author presents the aircraft designer with comprehensive principles of calculations. The time of publication is well chosen, as the German aircraft industry, which since the war has so far restricted itself to the licence construction of foreign aircraft, is now going over to developing its own.

A short introductory chapter gives the German official standard construction specifications (BVF 36) in force up to August 1957 in comparison with the currently valid American CAR regulations. A survey of various load factors and guiding principles for the measurement of components follows. Considerable space is devoted to design in modern light construction, integral, stressed skin and sandwich construction being amongst the types considered. The references could be more copious, and an index would be desirable. The user will, however, be grateful to find that the great many examples are illustrated by diagrams and worked right through in actual figures. Ge.

Nuclear Propulsion. — Edited by M. W. Thring. — Butterworth & Co. Ltd., London, 1960 (English; 300 pages with numerous illustrations; price 50s.).

A short historical introduction and a chapter on reactor physics are followed by a lucid treatment of the thermodynamic principles of jet and rocket powerplants. The main part of the work is devoted to nuclear reactors of various types and their applications in the propulsion of surface vessels, submarines, rockets, space vehicles, and aircraft. With emphasis on the only nuclear propulsion principle so far realized in a seagoing vessel, the author discusses the difficulties of screening radioactive radiations, as well as the control, safety and profitability of the use of nuclear powerplants in aircraft and rockets. The present state of development is clearly illustrated by drawings, diagrams and tables. There is a final chapter about the medical and biological effect of life in sealed cabins of space vehicles, and a short but interesting account of the uninspiring diet which will be the early spacemen's lot. Ge.

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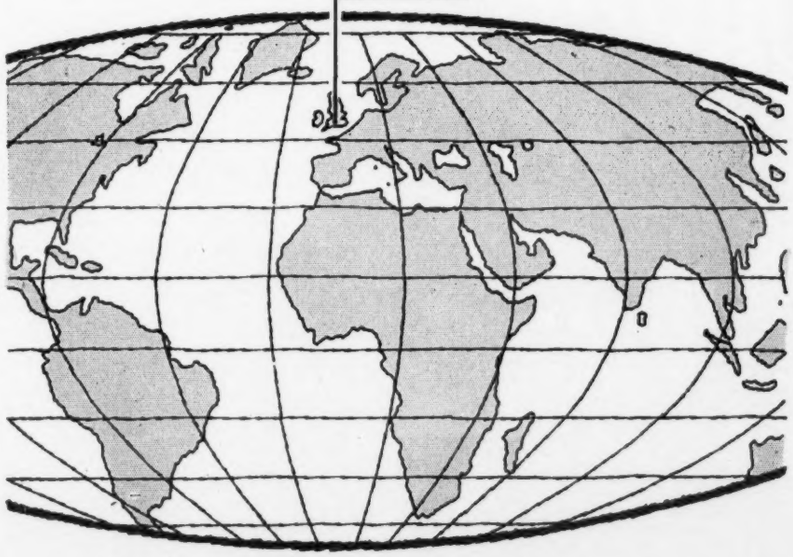

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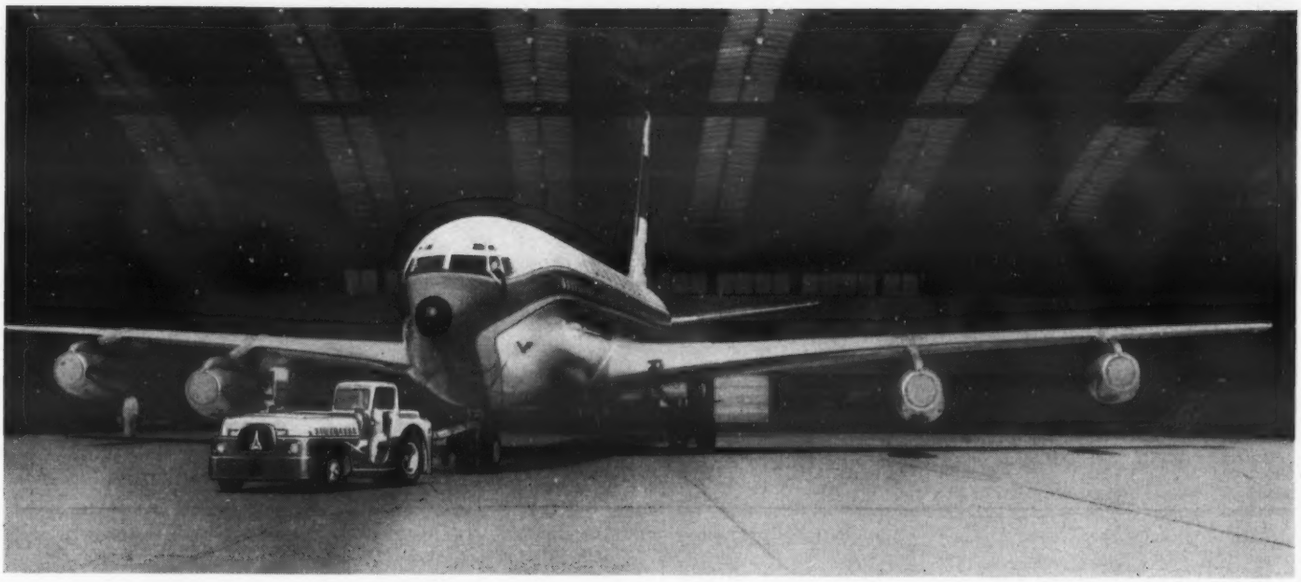

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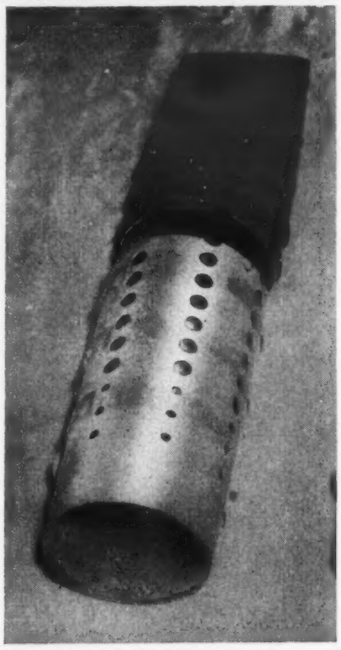

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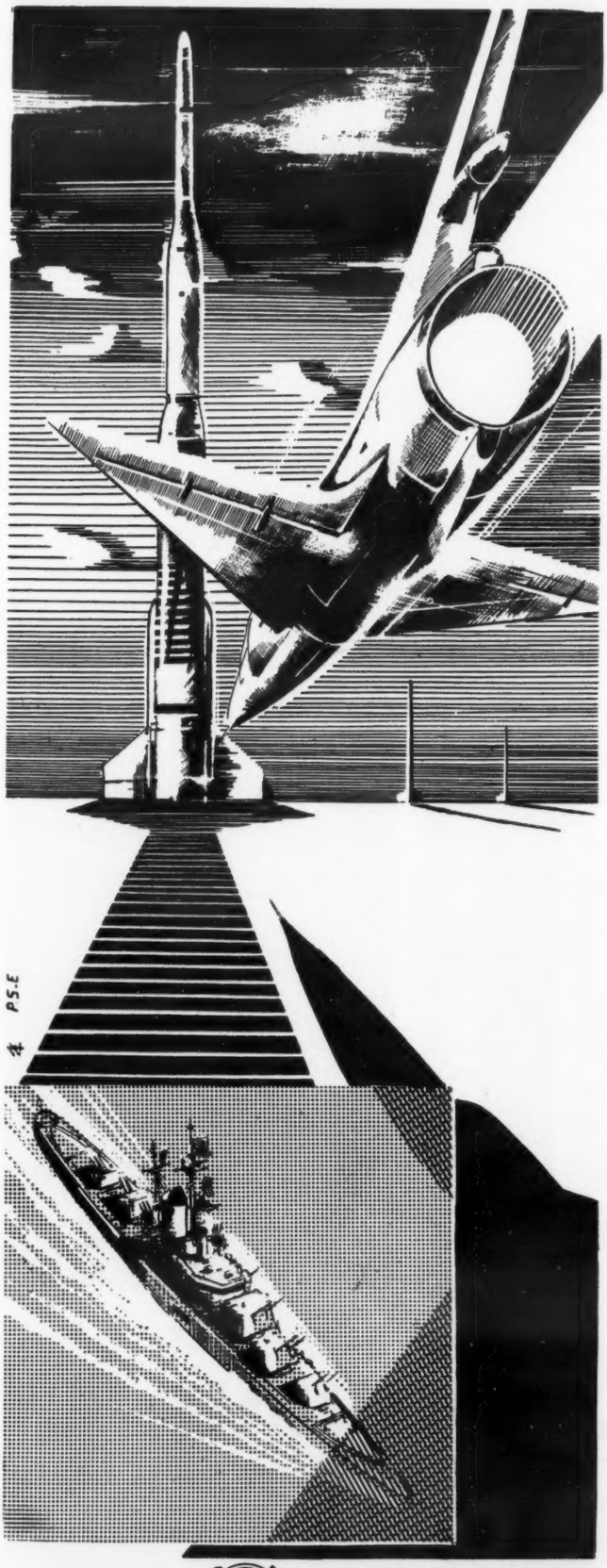

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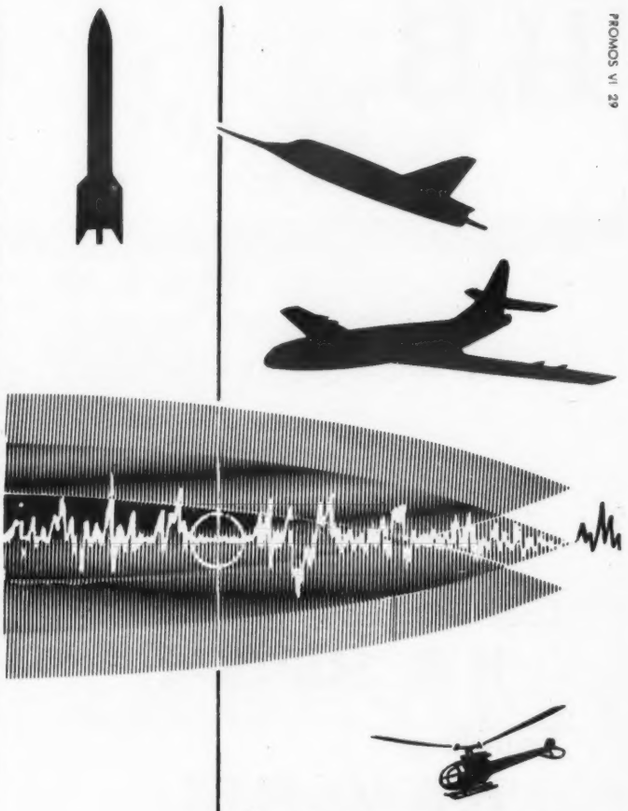

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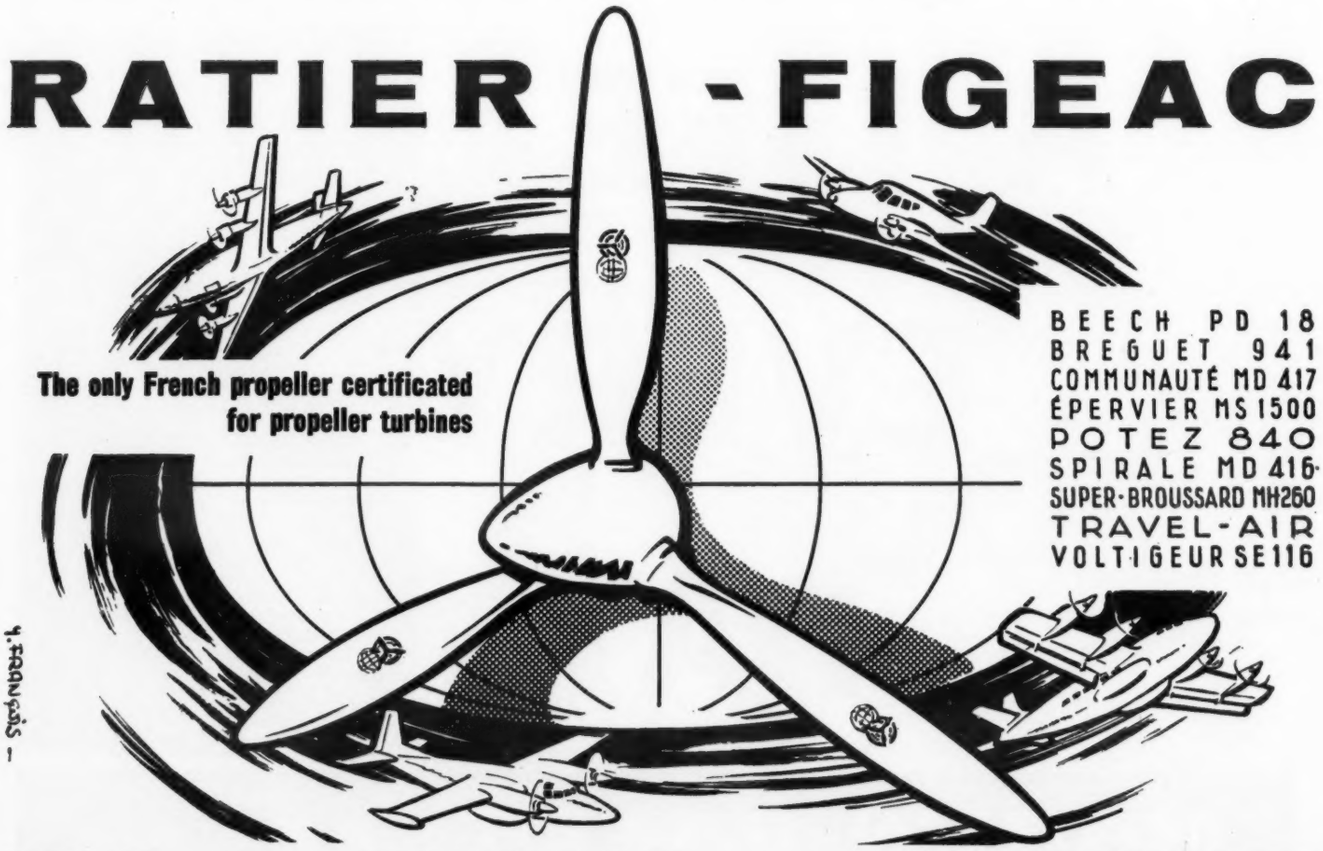

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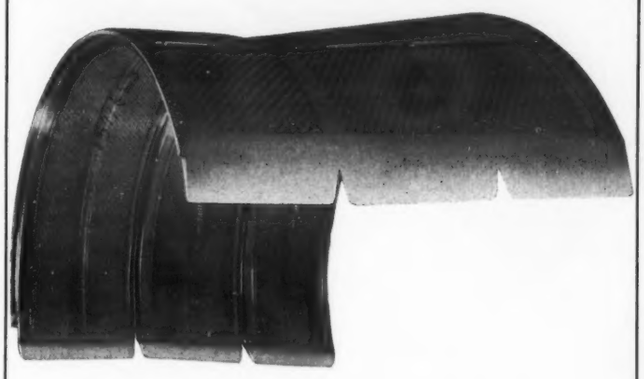

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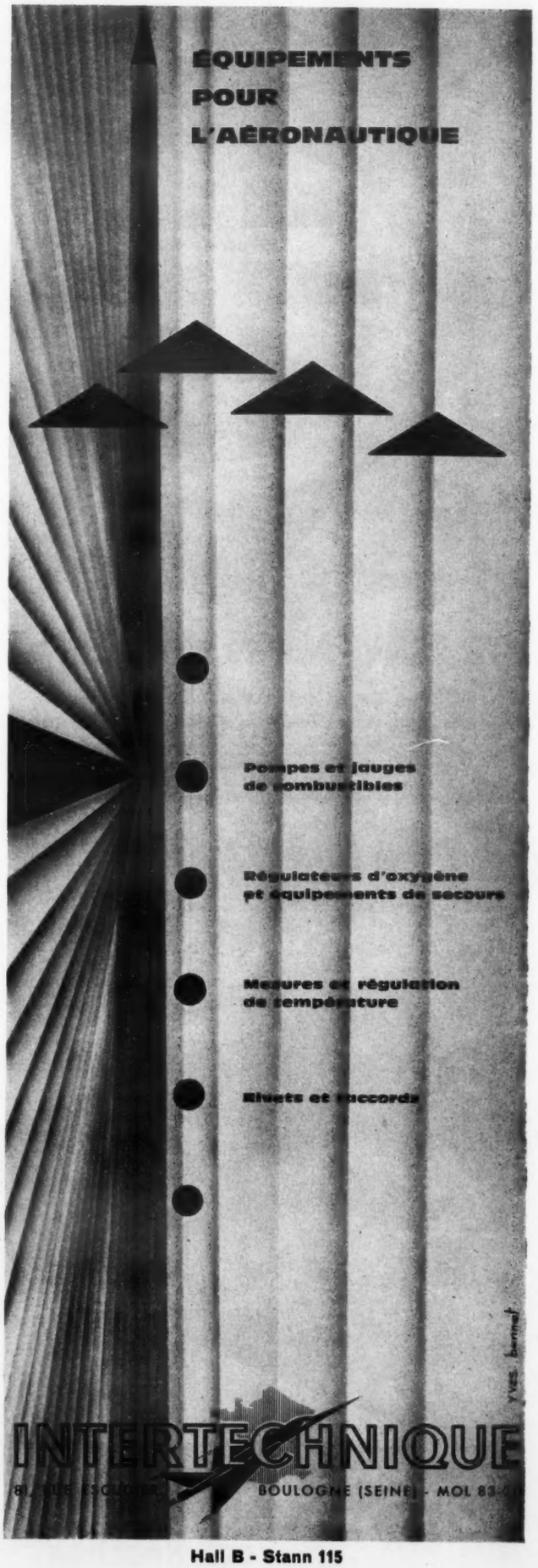

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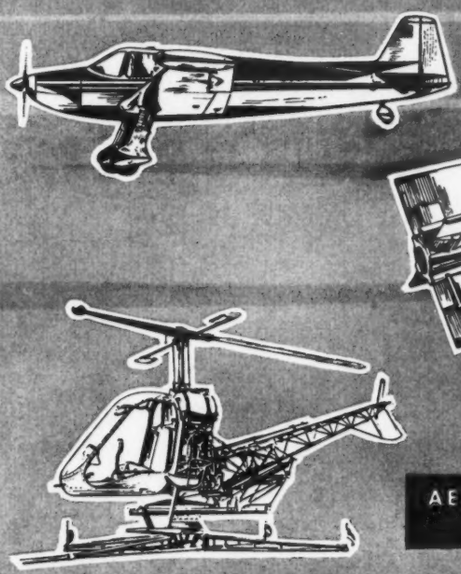

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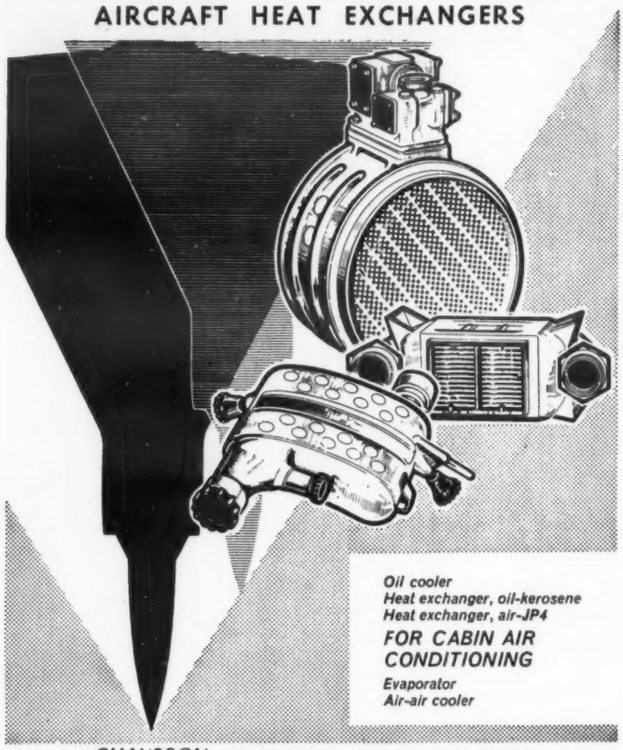

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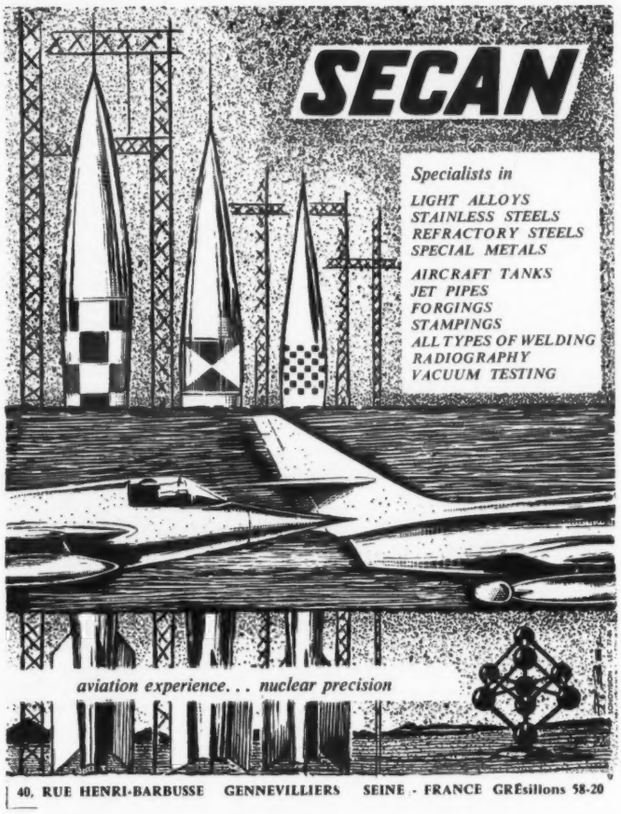

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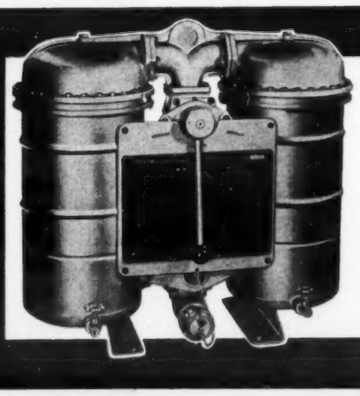

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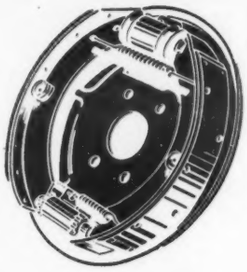

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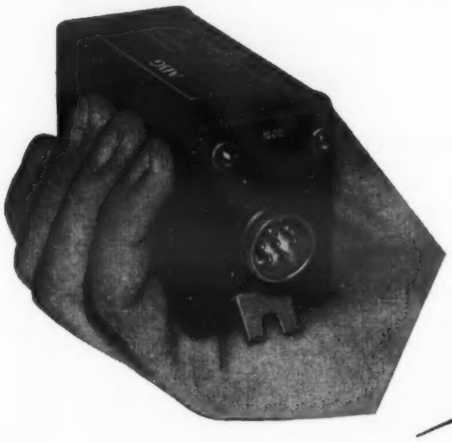

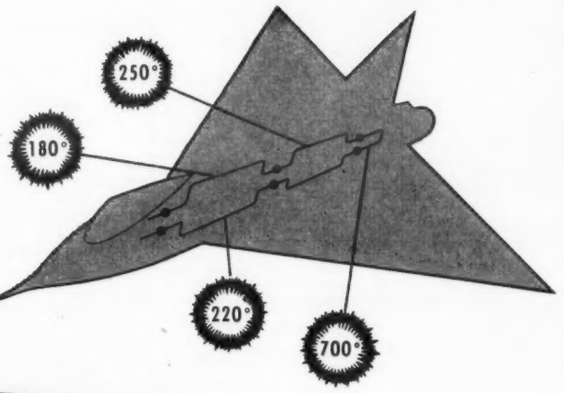

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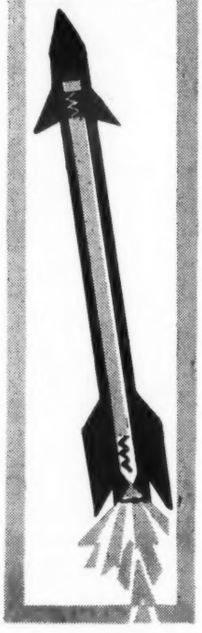

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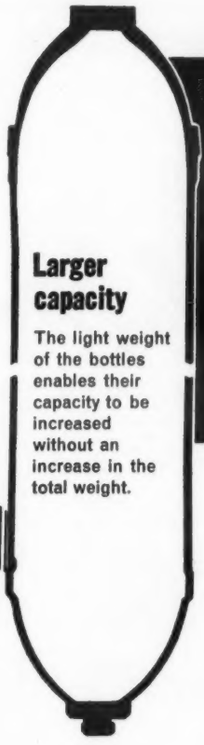

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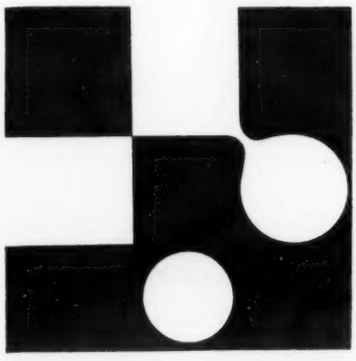

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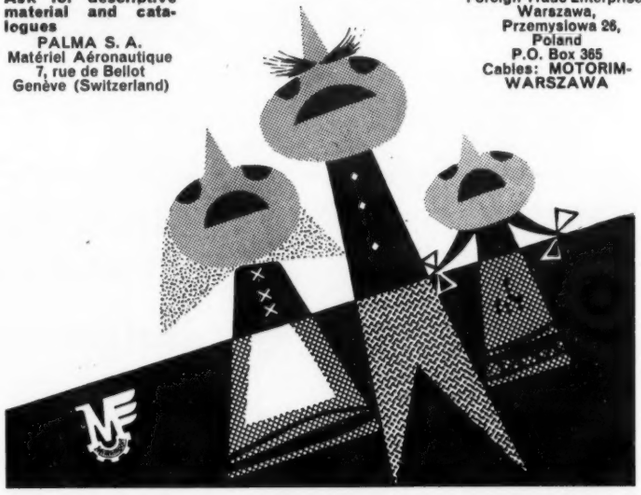

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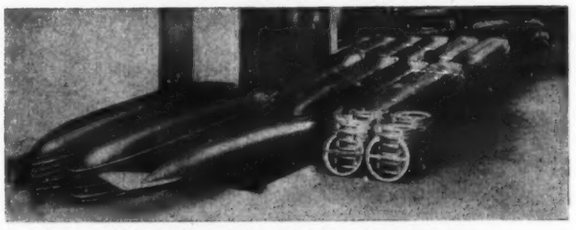

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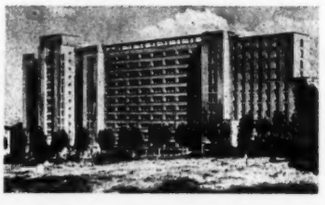

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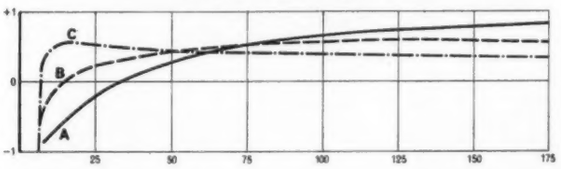

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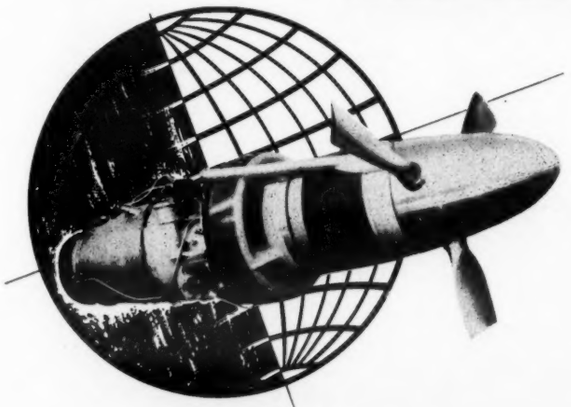

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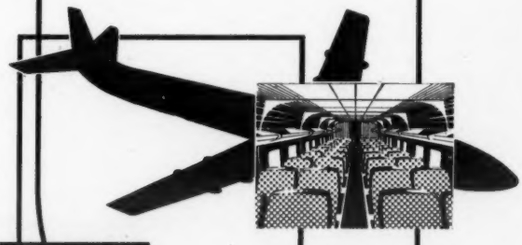

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